BERGER LAHR

Technical Documentation

Product manual

Portal axes with toothed belts

PAS4xB

Document: MNA1MLBDM00EN

Edition: V1.01, 08.2006

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Important information

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

See safety section for additional critical instructions.

Not all product variants are available in all countries.
Please consult the current catalogue for information on the availability of product variants.

We reserve the right to make changes during the course of technical developments.

All details provided are technical data and not promised characteristics.

In general, product names must be considered to be trademarks of the respective owners, even if not specifically identified as such.

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Writing conventions and symbols

Work steps

If work steps must be carried out in sequence, they are shown as follows:

- ■ Special prerequisites for the following work steps
- ▶ Step 1
- ◁ Important response to this work step
- ▶ Step 2

If a response to a work step is specified, this will inform you that the step has been carried out correctly.

Unless otherwise stated, the individual instruction steps must be carried in the given sequence.

Lists

Lists can be sorted alphanumerically or by priority. Lists are structured as follows:

- Point 1
- Point 2
  - – Subpoint to 2
  - – Subpoint to 2
- Point 3

Making work easier

Information on making work easier can be found at this symbol:

This offers supplementary information on making work easier.
See the chapter on safety for an explanation of the safety instructions.

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1 Introduction

1.1 Overview of product properties

The new toothed-belt portal axes are extremely flexible systems for attachment of drive systems with a variety of options such as rollers or recirculating ball bearing guides and an optional metal cover strip. Toothed-belt portal axes are used in situations in which loads must be positioned repetitively and accurately very dynamically over short and long distances.

The toothed belt axes can be fitted with up to three carriages for moving multiple or long loads. A parallel shaft-driven or driveless support axis is recommended for positioning wide-area or heavy loads.

Special features and options

- User-friendly structure
  - Easy system integration with section technology (ITEM-compatible T-section slots)
  - Carriage with threaded holes and locating dowels for reproducible support of the load
  - External lubrication
  - Heavy loads can be distributed over up to three carriages
  - Metal strip cover optional
  - Motor attachment by coupling system
  - Stroke length available to millimetre accuracy
  - Sensors can be moved anywhere in T-section slots
- Belt drive gear optional (1:1)
- Linear encoder measuring system optional

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1.2 Scope of supply

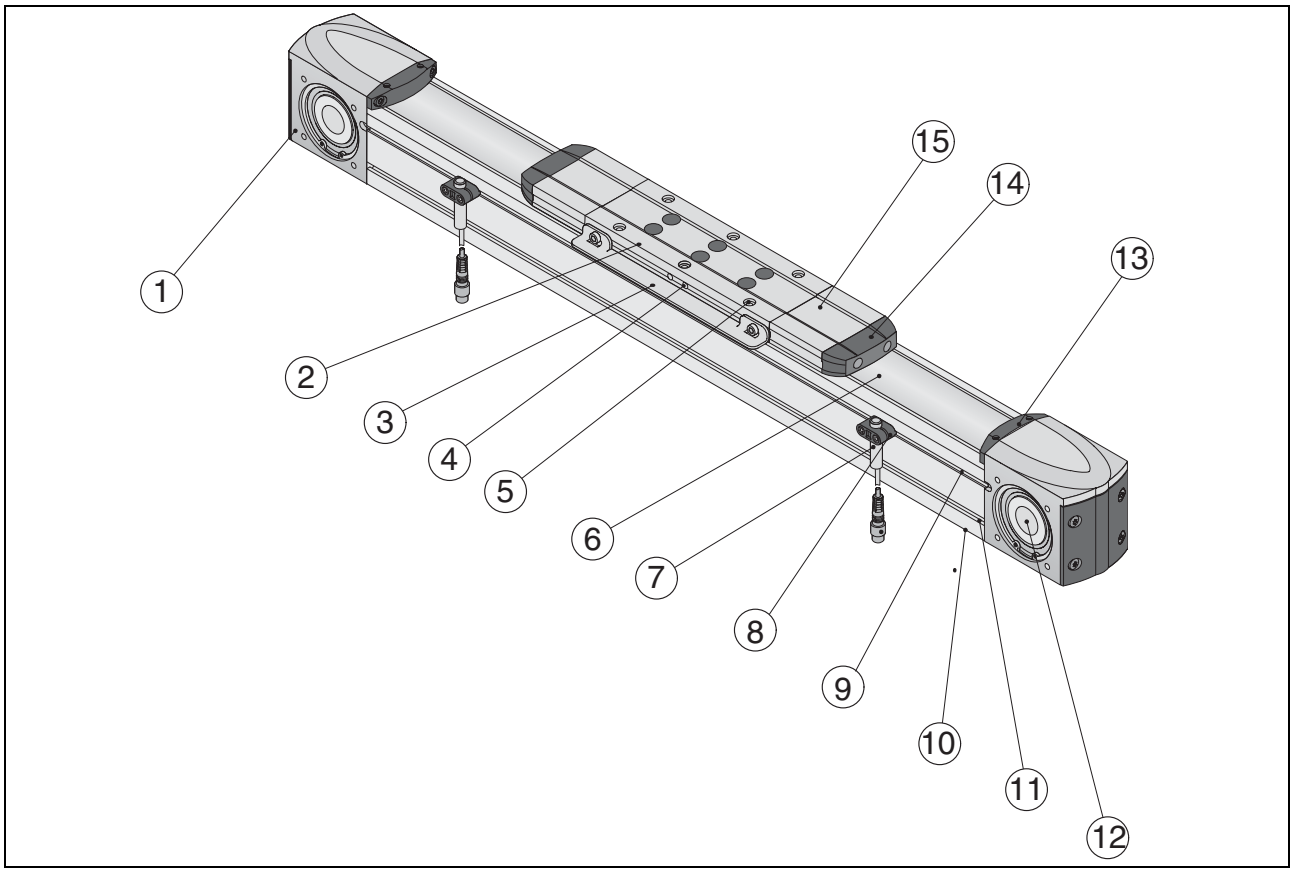

Figure 1.1 Components of a toothed belt axis

(1) End block
(2) Carriage
(3) Sensor contact plate
(4) Lubrication nipple
(5) Threaded holes for mounting the load
(6) Metal cover strip
(7) Sensor with connector cable
(8) Sensor retainer
(9) T-slot for fastening the sensor retainer
(10) Axial section
(11) T-slot fastening
(12) Hollow shaft for coupling or shaft journal
(13) Metal cover strip fastening
(14) Buffer
(15) Turning block

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1.3 Type code

Toothed belt axis	PAS	4	2	B	R	M	1200	C	1	N	B	100	R	N	/	V9
Product PAS = portal axis	**PAS**	4	2	B	R	M	1200	C	1	N	B	100	R	N	/	V9
product family 4 = basic line	PAS	**4**	2	B	R	M	1200	C	1	N	B	100	R	N	/	V9
Size (profile cross section) 1 = 40; (40 x 40 mm) 2 = 60; (60 x 60 mm) 3 = 80; (80 x 80 mm) 4 = 110; (110 x 110 mm)	PAS	4	**2**	B	R	M	1200	C	1	N	B	100	R	N	/	V9
Carriage drive B = toothed belt H = support axis (without drive, guide element only)	PAS	4	2	**B**	R	M	1200	C	1	N	B	100	R	N	/	V9
Guide type R =roller guide B = recirculating ball bearing guide	PAS	4	2	B	**R**	M	1200	C	1	N	B	100	R	N	/	V9
Feed per revolution M = in mm (81 with PAS41, 150 with PAS42, 205 with PAS43, 264 with PAS44) N = support axis	PAS	4	2	B	R	**M**	1200	C	1	N	B	100	R	N	/	V9
Stroke length XXXX = in mm	PAS	4	2	B	R	M	**1200**	C	1	N	B	100	R	N	/	V9
Limit switch [1)] A = 2 x PNP, normally closed contact, not wired B = 2 x PNP, normally closed contact, connected to IclA C = 2 x PNP, normally open contact, not wired D = 2 x PNP, normally open contact, connected to IclA E = 2 x NPN, normally closed contact, not wired F = 2 x NPN, normally closed contact, connected to IclA G = 2 x NPN, normally open contact, not wired H = 2 x NPN, normally open contact, connected to IclA N = without sensors	PAS	4	2	B	R	M	1200	**C**	1	N	B	100	R	N	/	V9
Carriage 1 = type 1 2 = type 2 4 = type 4	PAS	4	2	B	R	M	1200	C	**1**	N	B	100	R	N	/	V9
Options B = with cover strap C = corrosion-resistant, without cover strap A = antistatic-toothed belt, without cover strap E = corrosion-resistant, antistatic-toothed belt, without cover strap L = antistatic-toothed belt, with cover strap N = without options	PAS	4	2	B	R	M	1200	C	1	**N**	B	100	R	N	/	V9
Number of carriages A = one B = two C = three	PAS	4	2	B	R	M	1200	C	1	N	**B**	100	R	N	/	V9
Distance between carriages 1..999 = in mm xxx = with only one carriage	PAS	4	2	B	R	M	1200	C	1	N	B	**100**	R	N	/	V9

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Toothed belt axis	PAS	4	2	B	R	M	1200	C	1	N	B	100	R	N	/	V9
Axis drive interface H = without (hollow shaft both sides) L = with motor or toothed-belt drive gear left R = with motor or toothed-belt drive gear right A = with shaft left B = with shaft right C = with shaft both sides E = as in L and shaft right F = as in R and shaft left N = support axis	PAS	4	2	B	R	M	1200	C	1	N	B	100	**R**	N	/	V9
Toothed-belt drive gear N = without toothed-belt drive gear	PAS	4	2	B	R	M	1200	C	1	N	B	100	R	**N**	/	V9
Motor/gearing interface V6 - stepper motors VRDM364 / VRDM366 V8 - stepper motors VRDM368 V9 - stepper motors VRDM397 / VRDM3910 V0 - stepper motors VRDM3913 V1 - stepper motors VRDM311• I6 - IclA I•S61 / I•S62 with stepper motor I7 - IclA I•S63 with stepper motor I9 - IclA I•S91 / I•S92 with stepper motor I8 - IclA I•S93 with stepper motor S6 - servomotors SER36• S9 - servomotors SER39• S1 - servomotors SER311• A6 - IclA IFA6• with servomotor G9 - servomotors RIG39• G1 - servomotors RIG311• H5 - servomotors BSH055• H7 - servomotors BSH0701 / BSH0702 H8 - servomotors BSH0703 H1 - servomotors BSH1001 / BSH1002 / BSH1003 H4 - servomotors BSH1004 0G - planetary gear (Neugart) - PLE40 1G - planetary gear (Neugart) - PLE/WPLE60 3G - planetary gear (Neugart) - PLE/WPLE80 5G - planetary gear (Neugart) - PLE/WPLE120 7G - planetary gear (Neugart) - PLS70 8G - planetary gear (Neugart) - PLS90 XX - third-party motor / third-party gearing without attachment XY - third-party motor / third-party gearing with attachment	PAS	4	2	B	R	M	1200	C	1	N	B	100	R	N	/	**V9**

1) With 100 mm cable with connector wired at one end, other types as accessories

1.4 Documentation and literature references

The following User's manuals are supplied with this drive system:

- **Product manual**, describes the technical data, installation, commissioning and all operating modes and operating functions.
- **Motor manual**, describes the technical properties of the motors, including correct installation and commissioning.

The user's manuals can also be found in the Internet at http://www.schneider-motion.com/doku.

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1.5 Directives and standards

CE mark

With the declaration of conformity and the CE mark on the product the manufacturer certifies that the product complies with the requirements of all relevant EC directives.

EC Machine Directive

The drive systems described here are not machines as defined by the EC Machine Directive (98/37/EEC) but components for installation in machines. They do not have moving parts designed for specific purposes. However, they can be components of a machine or system.

The manufacturer must certify that the complete system conforms to the machine directive with the CE mark.

EC EMC Directive

The EC Electromagnetic Compatibility Directives (89/336/EEC) applies to products that cause electromagnetic interference or whose operation may be be adversely affected by electromagnetic interference.

Conformity with the EMC Directive can only be expected of drive systems after correct installation in the machine. The information on ensuring electromagnetic compatibility given in the chapter on "Installation" must be followed to ensure that the drive system in the machine or system is EMC-compatible and that the product can legally be operated.

EC Low-Voltage Directive

The EC Low-Voltage Directive (73/23/EEC) lays down safety requirements for 'electrical apparatus' as protection against the risks that can originate in such devices and can be created in response to external influences.

The drive systems described here comply with the EN 50178 Standard as per the Low-Voltage Directive.

Declaration of conformity

The declaration of conformity certifies that the drive system complies with the specific EC directive.

Standards for safe operation

EN ISO 12100-1: Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology

EN ISO 12100-2: Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles

EN 60204-1: Electrical equipment of machines, General requirements

EN 60529: IP degrees of protection

Standards for compliance with EMC limit values

EN 61800-3: Variable-speed electrical drives

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1.6 Manufacturer's Declaration

MANUFACTURER'S DECLARATION

BERGER LAHR

BERGER LAHR GmbH & Co. KG
Breslauer Str. 7
D-77933 Lahr

according to EC Directive on Machinery 98/37/EG

We hereby declare that the following product:

Designation:	Portal axis with toothed belt
Type:	PAS41x / PAS42x / PAS43x / PAS44x
Product number:	73xx xxxx xxx

in the version delivered is intended for installation in a machine. Commissioning is prohibited unless the machine meets the regulations according to the EC directives. Please observe the safety instructions in our technical documentation.

Applied harmonized standards, especially	EN ISO 12100-1: 2003-11 Safety of machinery basic concepts, principles for design Part 1: Basic terminology, methodology EN ISO 12100-2: 2003-11 Safety of machinery basic concepts, principles for design Part 2: Technical principles and specifications
Applied national standards and technical specifications, especially	

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Date/ Signature: 03.07.2006 ppa.

Name/ Department: Dr. Björn Hagemann / VP-Technology

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2 Safety

2.1 Qualification of personnel

Only technicians who are familiar with and understand the contents of this manual and the other relevant manuals are authorised to work on and with this drive system. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the mechanical, electrical and electronic equipment.

The technicians must have sufficient technical training, knowledge and experience to recognise and avoid dangers.

The technicians must be familiar with the relevant standards, regulations and safety regulations that must be observed when working on the drive system.

2.2 Intended use

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

In the system configuration described the drive systems must be used in industrial applications only and must have a fixed connection only.

In all cases the applicable safety regulations and the specified operating conditions, such as environmental conditions and specified technical data, must be observed.

The drive system must not be commissioned and operated until completion of installation in accordance with the EMC regulations and the specifications in this manual.

To prevent personal injury and damage to property damaged drive systems must not be installed or operated.

Changes and modifications of the drive systems are not permitted and if made all no warranty and liability will be accepted.

The drive system must be operated only with the specified wiring and approved accessories. In general, use only original accessories and spare parts.

The drive systems must not be operated in an environment subject to explosion hazard (ex area).

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2.3 General safety instructions

⚠ DANGER

Electric shock

High voltages at the motor connection may occur unexpectedly.

- Make sure that the drive (including DC bus) is disconnected from power before working on the drive system
- AC voltages may jump over unused wires in the motor cable. Isolate unused wires at both ends of the motor cable.
- The motor generates voltage when the shaft is rotated. Lock the motor shaft to prevent rotation before starting work on the drive system.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

Risk of injury by heavy weight, falling parts or crushing!

- Take the weight of the axis into account during mounting. It may be necessary to use a crane.
- Install the threaded fasteners (torque, screw locking) to ensure that axis and attachments do not come apart even under strong accelerations or continuous vibration.
- Note that axes subject to external forces (vertical axes) may drop unexpectedly.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING

Danger of injury by loss of control!

- Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)
- The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe state during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.
- The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.
- Suitable redundant control paths must be in place for dangerous functions.
- Check that measures taken are effective.

Failure to follow these instructions can result in death or serious injury.

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⚠ CAUTION

Hot surfaces can cause burns and damage to system components!

The drive temperature can exceed 100°C (212°F) in some conditions.

- Avoid contact with the hot drive.
- Do not place combustible or heat-sensitive components in immediate vicinity.
- Follow the actions described for heat dissipation.
- Check the temperature of the drive during the test run.

Failure to follow these instructions can result in injury or equipment damage.

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3 Technical Data

For definitions and explanations of terms see chapter 10 "Glossary".

3.1 Environmental conditions

When considering the ambient temperature a distinction is made between the permissible temperatures during operation and the permissible storage and transport temperature.

Ambient operating temperature

Temperature	[°C]	0 - +50

Ambient climate for transport and storage

The environment during transport and storage must be dry and dust-free. The maximum oscillation and shock stress must be within the specified limits. The bearing and transport temperature must remain within the specified range.

Temperature	[°C]	-25 ... +70

Relative humidity

The relative humidity is allowed as follows:

rel. air humidity	corresponding to IEC60721-3-3, Class 3K3, non-condensing

Installation height

Installation height above mean sea level for 100% power	[m]	< 1500

3.2 Mechanical data

Service life

Use the information in the catalogue to calculate the service life.

Repeat accuracy

The repeat accuracy is ± 0.05 mm. This value is influenced by temperature change, speed and load changes.

Stroke reserve

Size	Stroke reserve	
PAS41	[mm]	10
PAS42	[mm]	15
PAS43	[mm]	25
PAS44	[mm]	40

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3.2.1 PAS41x

Characteristic values		PAS41BR
Guide type		Roller guide
Max. payload	[kg]	6
Max. stroke length	[mm]	3000
Min. stroke length	[mm]	125
Max. speed	[m/s]	8
Max. acceleration	[m/s^2]	20
Max. drive force Fx_{dynmax}	[N]	300
Max. force Fy_{dynmax}	[N]	810
Max. force Fz_{dynmax}	[N]	520
Max. torque Mx_{dynmax}	[Nm]	6
Max. driving torque M_{max}	[Nm]	4
Load ratings drive system C_0/C_{dyn}	[N]	2230 / 3950
Repeat accuracy	[mm]	±0.05
No-load torque 0-stroke axis (without carriage)	[Nm]	0.11
Moment of inertia per m stroke	[$kgcm^2/m$]	0.11
Moment of inertia per kg payload	[$kgcm^2/kg$]	1.79
Moment of inertia of coupling assembly (without motor)	[$kgcm^2$]	0.03
Mass stroke per m stroke, with/without cover strap	[kg/m]	2.25 / 2.20
Mass of motor attachment (without motor)	[kg]	0.20
Internal diameter of clutch for motor attachment	[mm]	4 ... 12
Profile cross section (W x H)	[mm]	40 x 40
Shaft extension	[mm]	12 h7
Axial planar moment of inertia Ix/Iy	[mm^4]	76647 / 108936
Elasticity module (aluminium)	[N/mm^2]	0.72 x 10^5

Toothed belt / gear wheel		
Drive constant	[mm/rotat.]	84
Toothed belt width/pitch		15 / HTD3
Mass toothed belt per m	[kg/m]	0.03
Effective diameter toothed belt wheel (both sides equal)	[mm]	26.738
Width toothed belt wheel	[mm]	35
Material density toothed belt wheel	[kg/cm^3]	0.003
Moment of inertia toothed belt wheel	[$kgcm^2$]	0.02

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Carriage		PAS41BR	
		Type 2	Type 4
Max. torque of carriage My_{dynmax}	[Nm]	15	35
Max. torque of carriage Mz_{dynmax}	[Nm]	20	55
Max. stroke length with/without cover strap	[mm]	2910 / 3000	2830 / 2920
No-load torque of carriage	[Nm]	0.04	0.04
Moment of inertia 0-stroke axis with/without cover strap (without carriage)	[$kgcm^2$]	0.12 / 0.10	0.12 / 0.10
Moment of inertia of carriage (with/without cover strap)	[$kgcm^2$]	0.95 / 0.80	1.20 / 1.00
Mass of 0-stroke axis with/without cover strap (without motor, without carriage	[kg]	0.55 / 0.50	0.55 / 0.50
Mass of carriage with/without strap redirection (incl. toothed belt and profile component)	[kg]	1.20 / 0.90	1.50 / 1.20

Note: the listed forces and torques are based on an operational performance of 30000 km with recirculating ball bearing guides and 20000 km with roller guides.

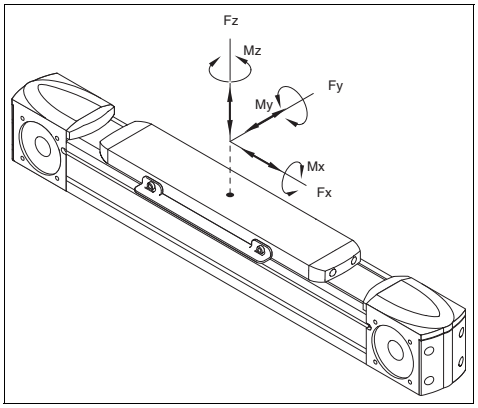

Figure 3.1 Forces and torques

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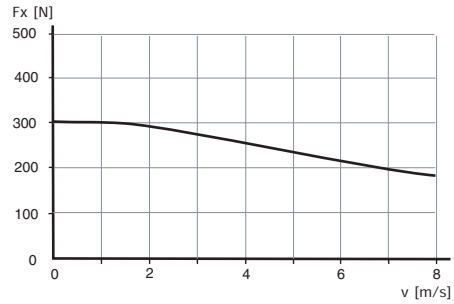
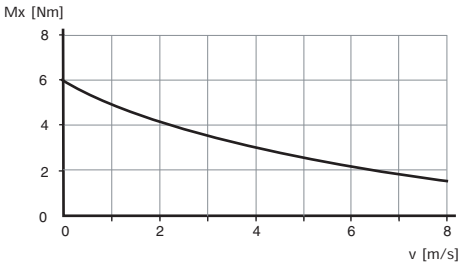
PAS41BR characteristic curves

Max. feed force Fx_{dynmax}

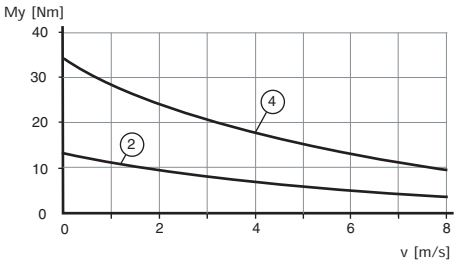


Max. torque Mx_{dynmax}

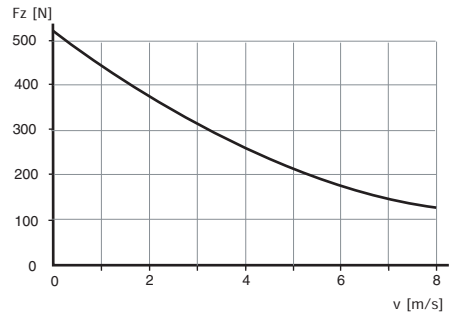


Max. force Fy_{dynmax}

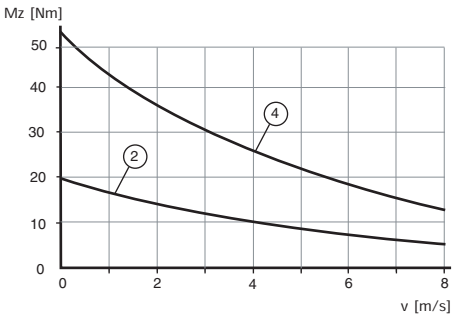
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

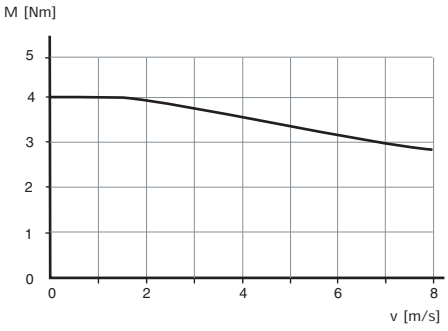


Max. torque of carriage Mz_{dynmax}



(2) Carriage type 2
(4) Carriage type 4

Max. driving torque M_{max}



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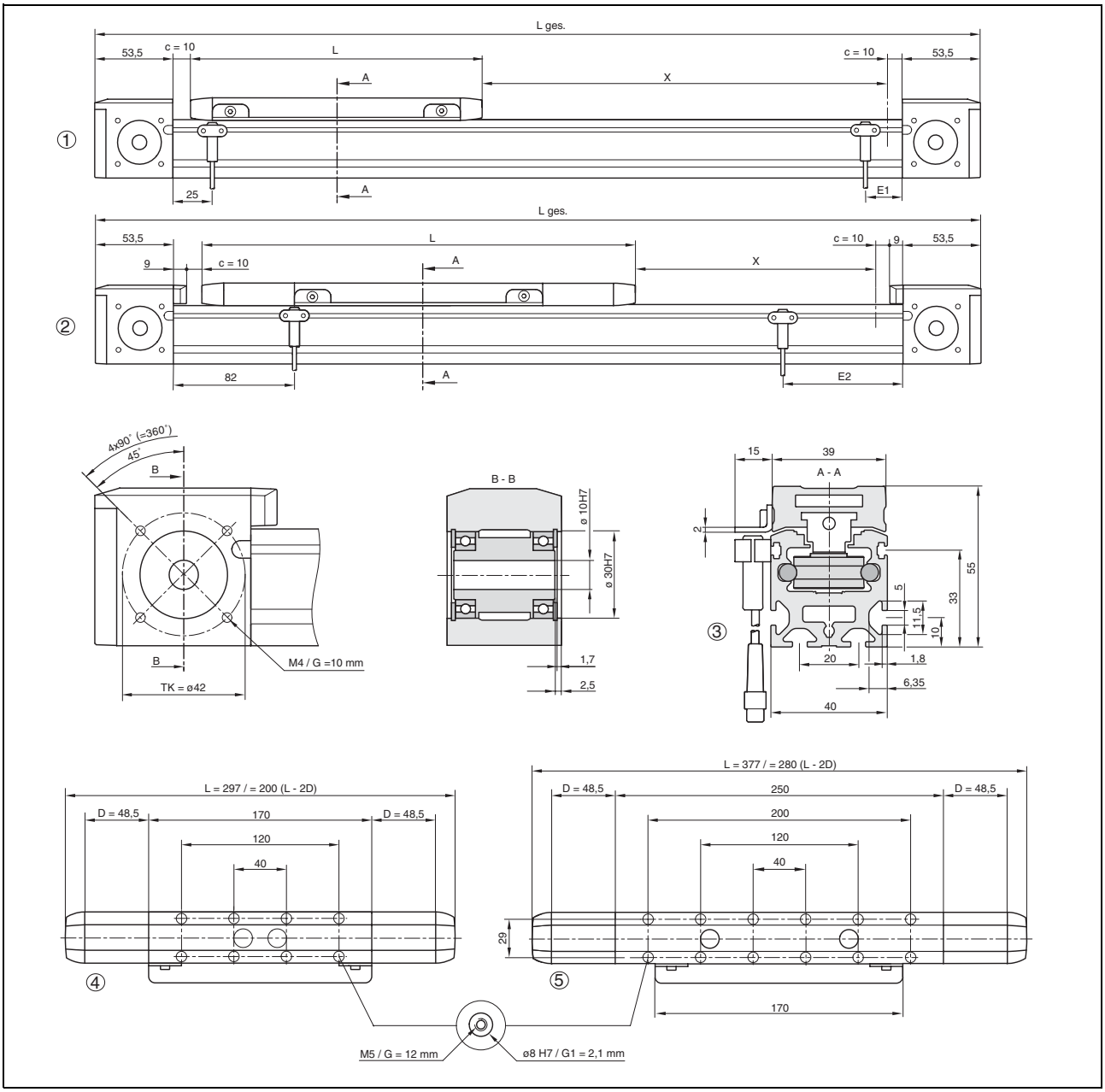

Figure 3.2 Dimensional drawings PAS41B

(1) = axis without cover strap	L total without cover strap = 127 + L + X (per additional carriage: + L + m)
(2) = axis with cover strap	L total with cover strap = 145 + L + X (per additional carriage: + L + m)
(3) = cross section with roller guide	L = carriage length with cover strap (without cover strap: L - 2D)
(4) = carriage type 2	x = working stroke
(5) = carriage type 4	m = minimum distance between 2 carriages with cover strap 90 mm, without cover strap 35 mm
	c = limit switch safety distances to the mechanical stop
	D = cover strap turning block
G = thread depth	E1 = carriage type 2: with cover strap 82 mm, without cover strap 25 mm
G1 = insertion depth	E2 = carriage type 4: with cover strap 162 mm, without cover strap 105 mm

3.2.2 PAS42x

Characteristic values		PAS42BR	PAS42BB
Guide type		Roller guide	Recirculating ball bearing guide
Max. payload	[kg]	12	24
Max. stroke length	[mm]	5500	5500
Min. stroke length	[mm]	130	9
Max. speed	[m/s]	8	5
Max. acceleration	[m/s^2]	20	20
Max. drive force Fx_{dynmax}	[N]	800	800
Max. force Fy_{dynmax}	[N]	810	2805
Max. force Fz_{dynmax}	[N]	520	2805
Max. torque Mx_{dynmax}	[Nm]	11	19
Max. driving torque M_{max}	[Nm]	20	20
Load ratings drive system C_0/C_{dyn}	[N]	2230 / 3950	24200 / 14200
Repeat accuracy	[mm]	±0.05	±0.05
No-load torque 0-stroke axis (without carriage)	[Nm]	0.64	0.64
Moment of inertia per m stroke	[$kgcm^2/m$]	1.20	1.20
Moment of inertia per kg payload	[$kgcm^2/kg$]	6.10	6.10
Moment of inertia of coupling assembly (without motor)	[$kgcm^2$]	0.24	0.24
Mass stroke per m stroke, with/without cover strap	[kg/m]	4.55 / 4.50	5.60 / 5.50
Mass of motor attachment (without motor)	[kg]	0.5	0.5
Internal diameter of clutch for motor attachment	[mm]	6.35 ... 20	6.35 ... 20
Profile cross section (W x H)	[mm]	60 x 60	60 x 60
Shaft extension	[mm]	20 h7	20 h7
Axial planar moment of inertia Ix/Iy	[mm^4]	435394 / 651612	435394 / 651612
Elasticity module (aluminium)	[N/mm^2]	0.72 x 10^5	0.72 x 10^5

Toothed belt / gear wheel			
Drive constant	[mm/rotat.]	155	155
Toothed belt width/pitch		25 / HTD5	25 / HTD5
Mass toothed belt per m	[kg/m]	0.10	0.10
Effective diameter toothed belt wheel (both sides equal)	[mm]	49.338	49.338
Width toothed belt wheel	[mm]	52	52
Material density toothed belt wheel	[kg/cm^3]	0.003	0.003
Moment of inertia toothed belt wheel	[$kgcm^2$]	0.50	0.50

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Carriage		PAS42BR		PAS42BB	
		Type 1	Type 4	Type 1	Type 4
Max. torque of carriage My_{dynmax}	[Nm]	23	70	75	365
Max. torque of carriage Mz_{dynmax}	[Nm]	35	110	75	365
Max. stroke length with/without cover strap	[mm]	5380 / 5500	5200 / 5320	5380 / 5500	5200 / 5320
No-load torque of carriage	[Nm]	0.08	0.08	0.35	0.35
Moment of inertia 0-stroke axis with/without cover strap (without carriage)	[$kgcm^2$]	1.90 / 1.75	2.00 / 1.85	1.90 / 1.75	2.00 / 1.85
Moment of inertia of carriage (with/without cover strap)	[$kgcm^2$]	6.10 / 5.50	10.15 / 9.60	6.90 / 6.30	10.20 / 9.55
Mass of 0-stroke axis with/without cover strap (without motor, without carriage	[kg]	1.70 / 1.55	1.70 / 1.55	1.75 / 1.60	1.75 / 1.60
Mass of carriage with/without strap redirection (incl. toothed belt and profile component)	[kg]	2.40 / 1.85	3.90 / 3.30	2.80 / 2.20	4.35 / 3.70

Note: the listed forces and torques are based on an operational performance of 30000 km with recirculating ball bearing guides and 20000 km with roller guides.

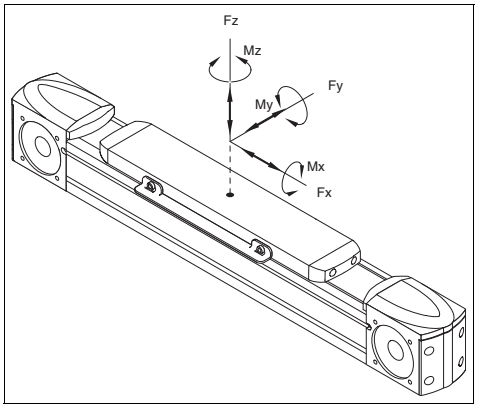

Figure 3.3 Forces and torques

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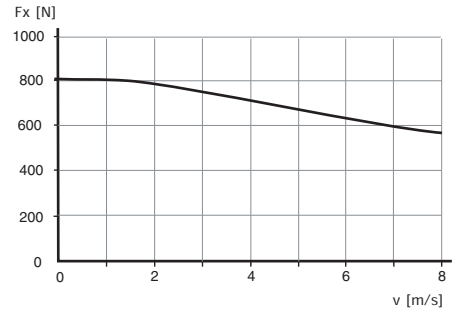
PAS42BR characteristic curves

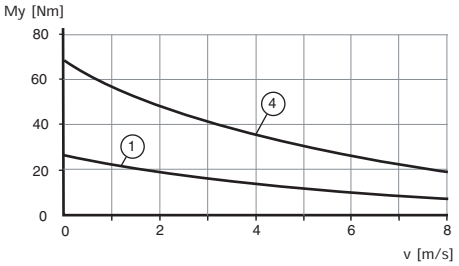
Max. feed force Fx_{dynmax}



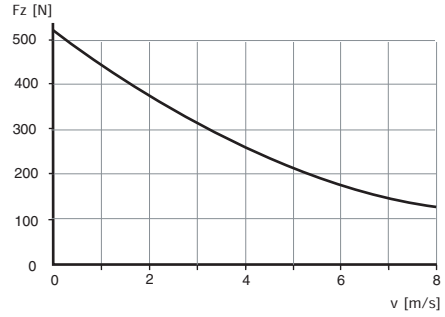
Max. torque Mx_{dynmax}

Max. force Fy_{dynmax}

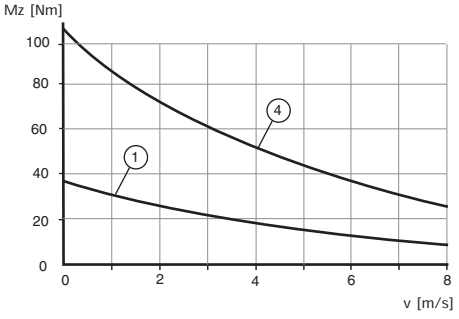
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

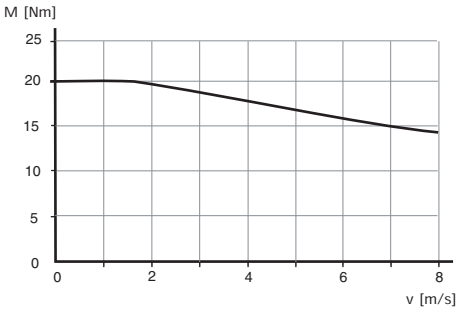


Max. torque of carriage Mz_{dynmax}



(1) Carriage type 1
(4) Carriage type 4

Max. driving torque M_{max}



PAS42BB characteristic curves

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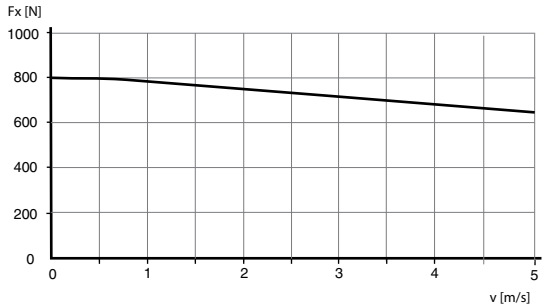
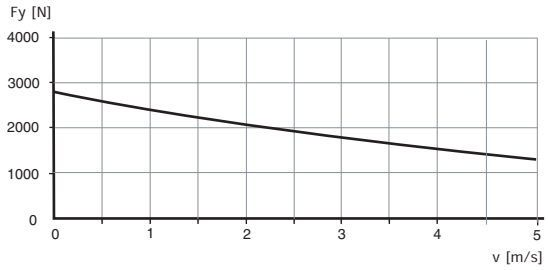
Max. feed force Fx_{dynmax}

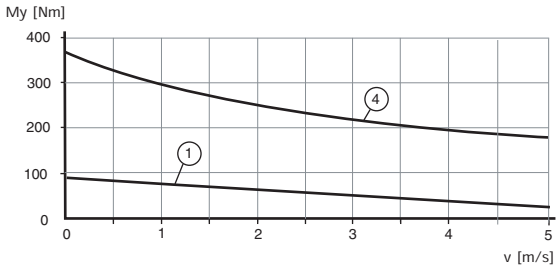


Max. torque Mx_{dynmax}

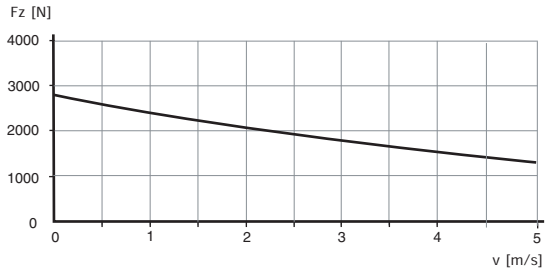
Max. force Fy_{dynmax}



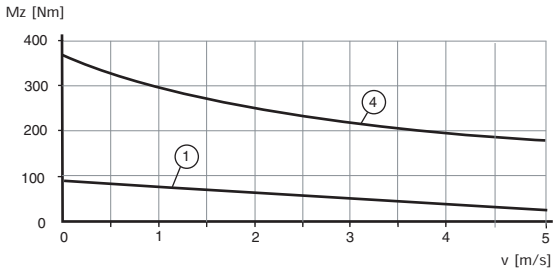
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

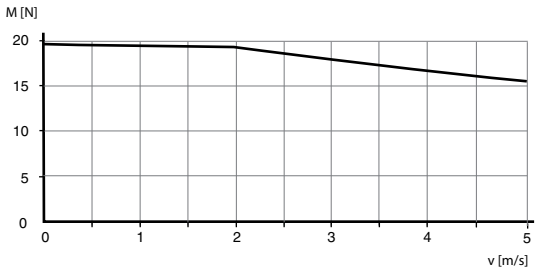


Max. torque of carriage Mz_{dynmax}



(1) Carriage type 1
(4) Carriage type 4

Max. driving torque M_{max}



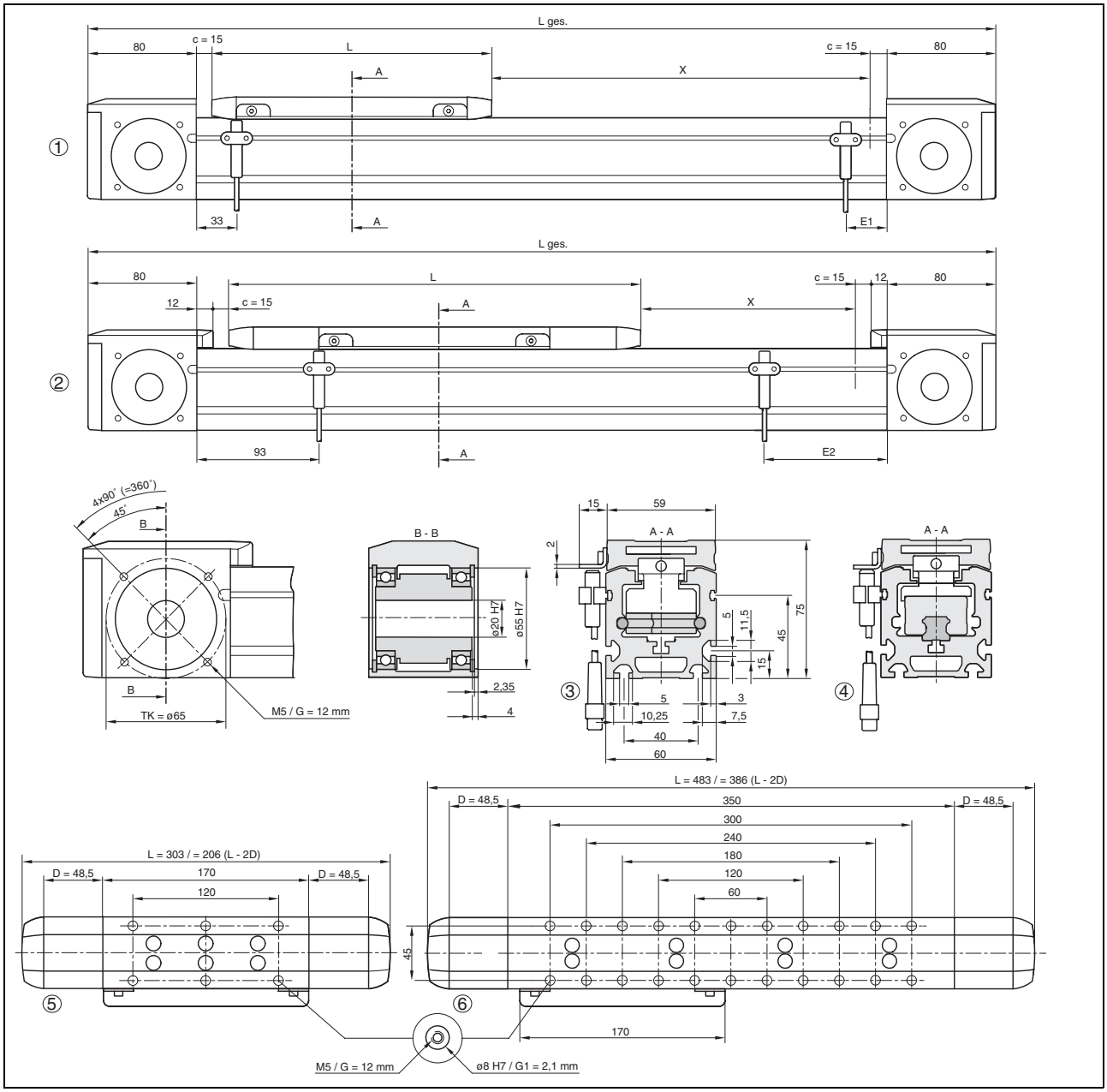


Figure 3.4 Dimensional drawings PAS42B

(1) = axis without cover strap	L total without cover strap = 190 + L + X (per additional carriage: + L + m)
(2) = axis with cover strap	L total with cover strap = 214 + L + X (per additional carriage: + L + m)
(3) = cross section with roller guide	L = carriage length with cover strap (without cover strap: L - 2D)
(4) = cross section with recirculating ball bearing guide	x = working stroke
(5) = carriage type 1	m = minimum distance between 2 carriages with cover strap 90 mm, without cover strap 40 mm
(6) = carriage type 4	c = limit switch safety distances to the mechanical stop
	D = cover strap turning block
G = thread depth	E1 = carriage type 1: with cover strap 93 mm, without cover strap 33 mm
G1 = insertion depth	E2 = carriage type 4: with cover strap 273 mm, without cover strap 213 mm

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3.2.3 PAS43x

Characteristic values		PAS43BR	PAS43BB
Guide type		Roller guide	Recirculating ball bearing guide
Max. payload	[kg]	30	60
Max. stroke length	[mm]	5500	5500
Min. stroke length	[mm]	175	11
Max. speed	[m/s]	8	5
Max. acceleration	[m/s^2]	20	20
Max. drive force Fx_{dynmax}	[N]	1100	1100
Max. force Fy_{dynmax}	[N]	2130	4410
Max. force Fz_{dynmax}	[N]	1255	4410
Max. torque Mx_{dynmax}	[Nm]	36	42
Max. driving torque M_{max}	[Nm]	36	36
Load ratings drive system C_0/C_{dyn}	[N]	4850 / 8500	38400 / 22300
Repeat accuracy	[mm]	±0.05	±0.05
No-load torque 0-stroke axis (without carriage)	[Nm]	0.75	0.75
Moment of inertia per m stroke	[$kgcm^2/m$]	2.50	2.50
Moment of inertia per kg payload	[$kgcm^2/kg$]	10.65	10.65
Moment of inertia of coupling assembly (without motor)	[$kgcm^2$]	0.90	0.90
Mass stroke per m stroke, with/without cover strap	[kg/m]	8.00 / 7.95	9.50 / 9.45
Mass of motor attachment (without motor)	[kg]	1.0	1.0
Internal diameter of clutch for motor attachment	[mm]	12 ... 25	12 ... 25
Profile cross section (W x H)	[mm]	80 x 80	80 x 80
Shaft extension	[mm]	25 h7	25 h7
Axial planar moment of inertia lx/ly	[mm^4]	1285262 / 1867213	1285262 / 1867213
Elasticity module (aluminium)	[N/mm^2]	0.72 x 10^5	0.72 x 10^5

Toothed belt / gear wheel			
Drive constant	[mm/rotat.]	205	205
Toothed belt width/pitch		30 / HTD5	30 / HTD5
Mass toothed belt per m	[kg/m]	0.12	0.12
Effective diameter toothed belt wheel (both sides equal)	[mm]	65.254	65.254
Width toothed belt wheel	[mm]	71	71
Material density toothed belt wheel	[kg/cm^3]	0.003	0.003
Moment of inertia toothed belt wheel	[$kgcm^2$]	2.04	2.50

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Carriage		PAS43BR		PAS43BB	
		Type 1	Type 4	Type 1	Type 4
Max. torque of carriage My_{dynmax}	[Nm]	62	195	165	690
Max. torque of carriage Mz_{dynmax}	[Nm]	105	330	165	690
Max. stroke length with/without cover strap	[mm]	5350 / 5500	5140 / 5290	5350 / 5500	5140 / 5290
No-load torque of carriage	[Nm]	0.25	0.25	0.82	0.82
Moment of inertia 0-stroke axis with/without cover strap (without carriage)	[kgcm^2]	8.10 / 7.70	8.35 / 8.00	8.10 / 7.70	8.35 / 8.00
Moment of inertia of carriage (with/without cover strap)	[kgcm^2]	23.20 / 20.00	38.00 / 34.50	25.00 / 21.80	37.35 / 34.20
Mass of 0-stroke axis with/without cover strap (without motor, without carriage	[kg]	4.40 / 4.10	4.40 / 4.10	4.40 / 4.10	4.40 / 4.10
Mass of carriage with/without strap redirection (incl. toothed belt and profile component)	[kg]	5.10 / 3.80	8.15 / 6.85	5.80 / 4.35	9.00 / 7.50

Note: the listed forces and torques are based on an operational performance of 30000 km with recirculating ball bearing guides and 20000 km with roller guides.

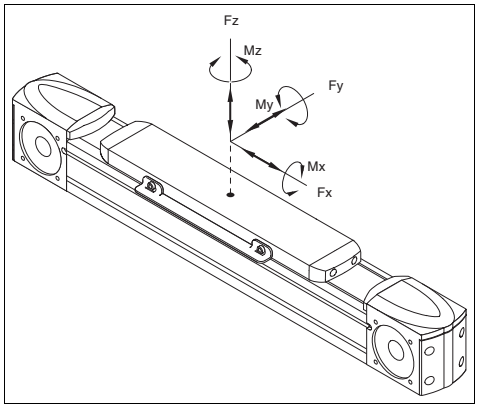

Figure 3.5 Forces and torques

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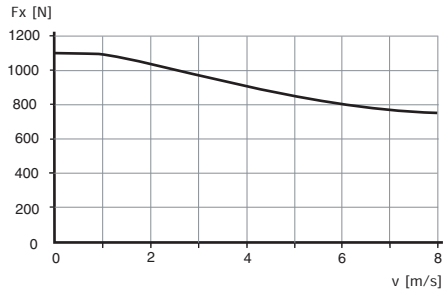
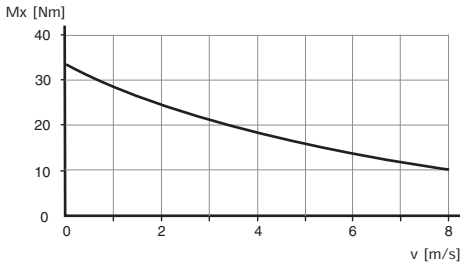
PAS43BR characteristic curves

Max. feed force Fx_{dynmax}

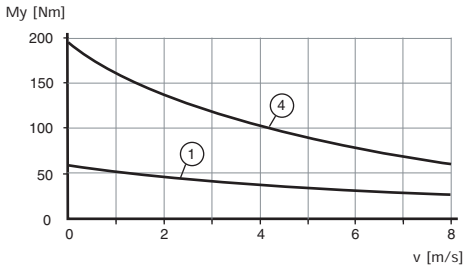


Max. torque Mx_{dynmax}

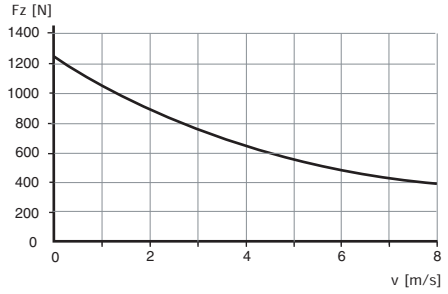


Max. force Fy_{dynmax}

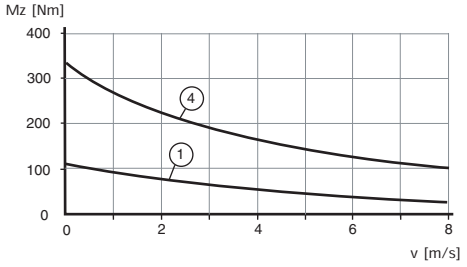
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

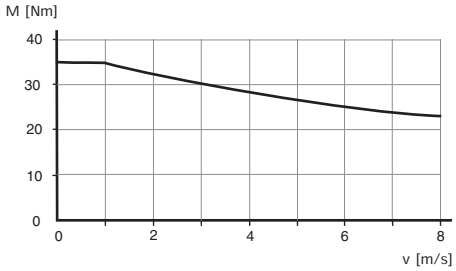


Max. torque of carriage Mz_{dynmax}



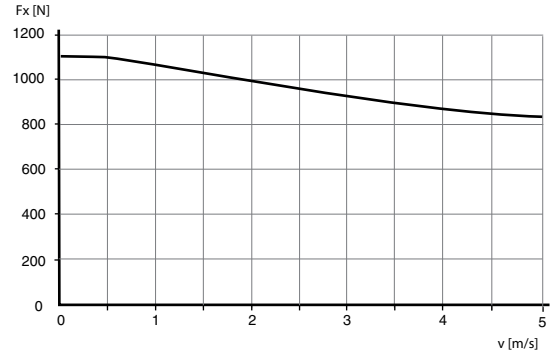
(1) Carriage type 1
(4) Carriage type 4

Max. driving torque M_{max}

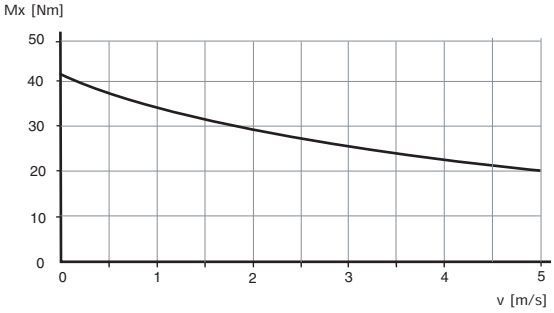


PAS43BB characteristic curves

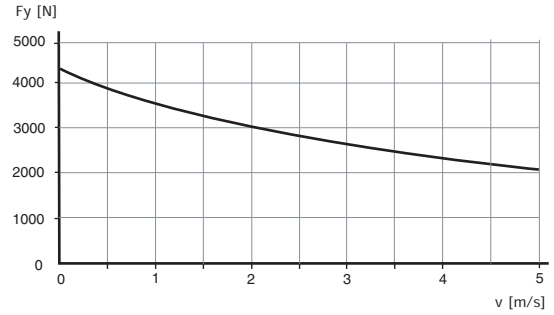
Max. feed force Fx_{dynmax}



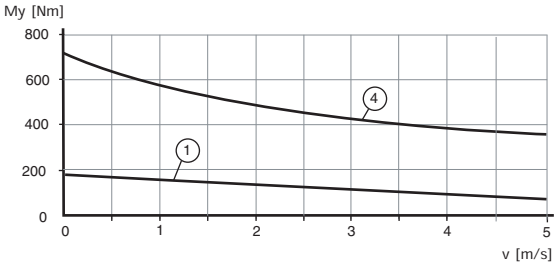
Max. torque Mx_{dynmax}



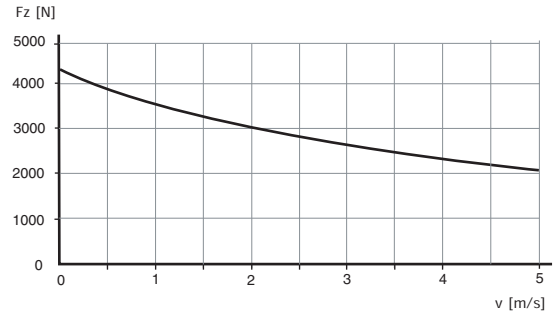
Max. force Fy_{dynmax}



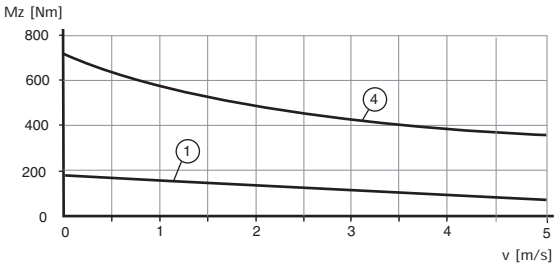
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

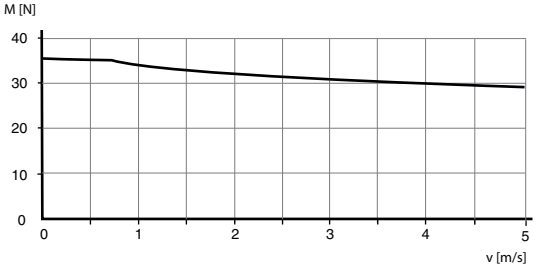


Max. torque of carriage Mz_{dynmax}



(1) Carriage type 1
(4) Carriage type 4

Max. driving torque M_{max}



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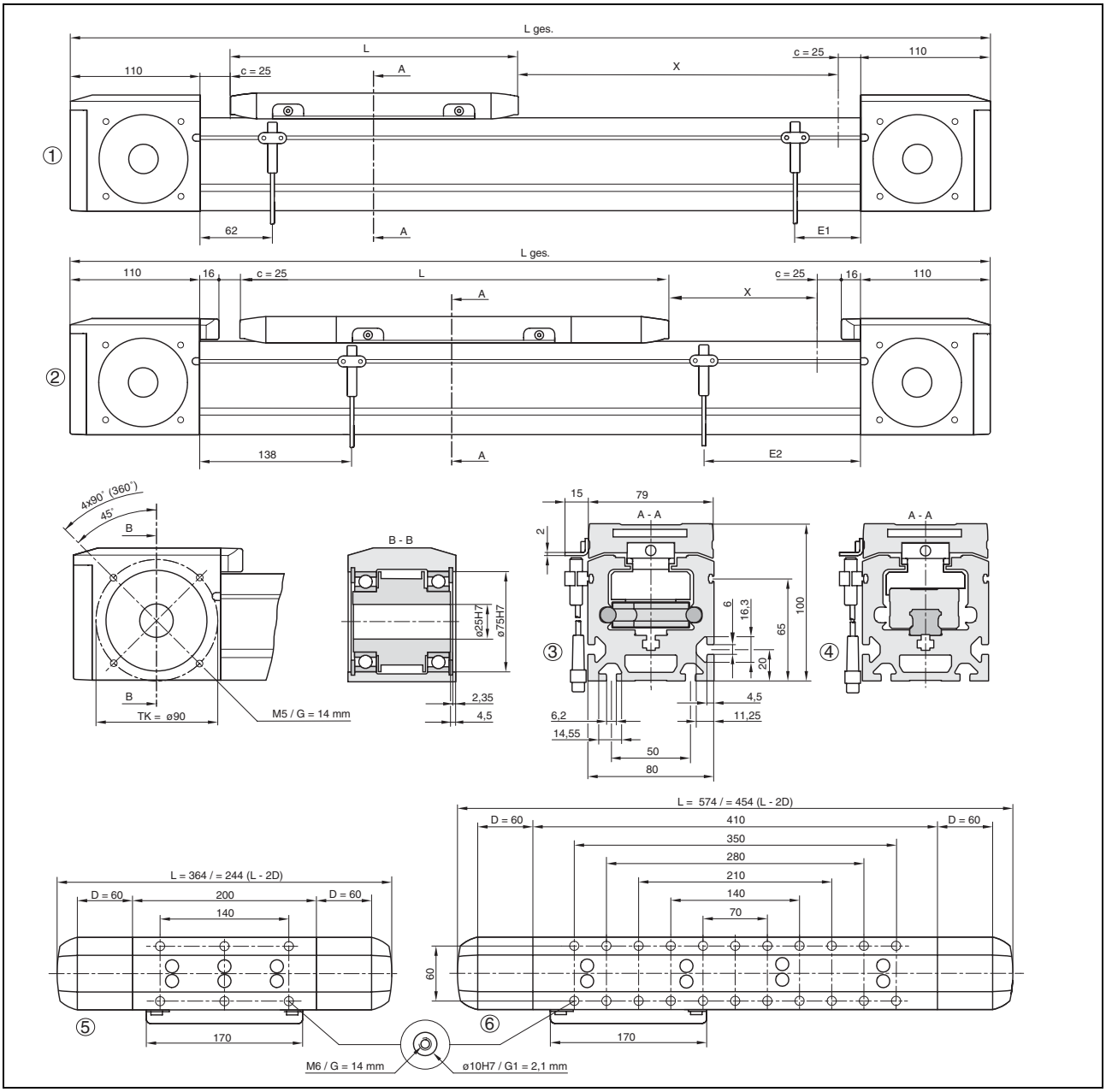

Figure 3.6 Dimensional drawings PAS43B

(1) = axis without cover strap	L total without cover strap = 270 + L + X (per additional carriage: + L + m)
(2) = axis with cover strap	L total with cover strap = 302 + L + X (per additional carriage: + L + m)
(3) = cross section with roller guide	L = carriage length with cover strap (without cover strap: L - 2D)
(3) = cross section with recirculating ball bearing guide	x = working stroke
(5) = carriage type 1	m = minimum distance between 2 carriages with cover strap 110 mm, without cover strap 45 mm
(6) = carriage type 4	c = limit switch safety distances to the mechanical stop
	D = cover strap turning block
G = thread depth	E1 = carriage type 1: with cover strap 93 mm, without cover strap 33 mm
G1 = insertion depth	E2 = carriage type 4: with cover strap 273 mm, without cover strap 213 mm

3.2.4 PAS44x

Characteristic values		PAS44BB
Guide type		Recirculating ball bearing guide
Max. payload	[kg]	100
Max. stroke length	[mm]	5500
Min. stroke length	[mm]	13
Max. speed	[m/s]	5
Max. acceleration	[m/s^2]	20
Max. drive force Fx_{dynmax}	[N]	2600
Max. force Fy_{dynmax}	[N]	6250
Max. force Fz_{dynmax}	[N]	6250
Max. torque Mx_{dynmax}	[Nm]	67
Max. driving torque M_{max}	[Nm]	110
Load ratings drive system C_0/C_{dyn}	[N]	52400 / 31700
Repeat accuracy	[mm]	±0.05
No-load torque 0-stroke axis (without carriage)	[Nm]	2.50
Moment of inertia per m stroke	[$kgcm^2/m$]	11.00
Moment of inertia per kg payload	[$kgcm^2/kg$]	17.70
Moment of inertia of coupling assembly (without motor)	[$kgcm^2$]	2.10
Mass stroke per m stroke, with/without cover strap	[kg/m]	16.85 / 16.80
Mass of motor attachment (without motor)	[kg]	2.0
Internal diameter of clutch for motor attachment	[mm]	12 ... 32
Profile cross section (W x H)	[mm]	110 x 110
Shaft extension	[mm]	32 h7
Axial planar moment of inertia Ix/Iy	[mm^4]	4713499 / 6624690
Elasticity module (aluminium)	[N/mm^2]	0.72 x 10^5

Toothed belt / gear wheel		
Drive constant	[mm/rotat.]	264
Toothed belt width/pitch		50 / HTD8
Mass toothed belt per m	[kg/m]	0.31
Effective diameter toothed belt wheel (both sides equal)	[mm]	84.034
Width toothed belt wheel	[mm]	98
Material density toothed belt wheel	[kg/cm^3]	0.003
Moment of inertia toothed belt wheel	[$kgcm^2$]	7.03

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Carriage		PAS44BB	
		Type 1	Type 4
Max. torque of carriage My_{dynmax}	[Nm]	260	1210
Max. torque of carriage Mz_{dynmax}	[Nm]	260	1210
Max. stroke length with/without cover strap	[mm]	5300 / 5500	5030 / 5230
No-load torque of carriage	[Nm]	1.35	1.35
Moment of inertia 0-stroke axis with/without cover strap (without carriage)	[$kgcm^2$]	28.00 / 25.85	29.50 / 27.00
Moment of inertia of carriage (with/without cover strap)	[$kgcm^2$]	84.90 / 72.90	133.00 / 121.00
Mass of 0-stroke axis with/without cover strap (without motor, without carriage	[kg]	10.50 / 9.85	10.50 / 9.85
Mass of carriage with/without strap redirection (incl. toothed belt and profile component)	[kg]	12.70 / 9.30	20.00 / 16.60

Note: the listed forces and torques are based on an operational performance of 30000 km with recirculating ball bearing guides and 20000 km with roller guides.

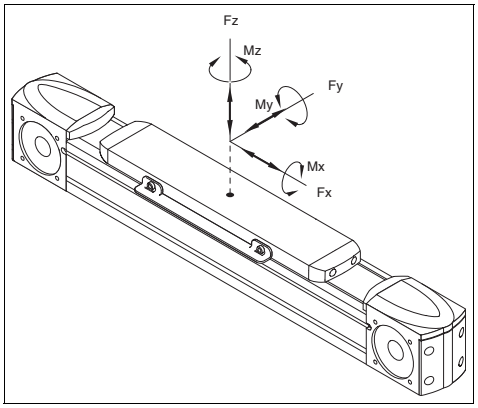

Figure 3.7 Forces and torques

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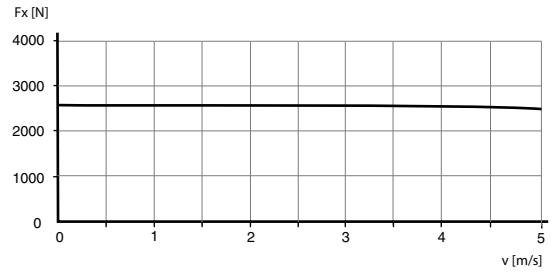
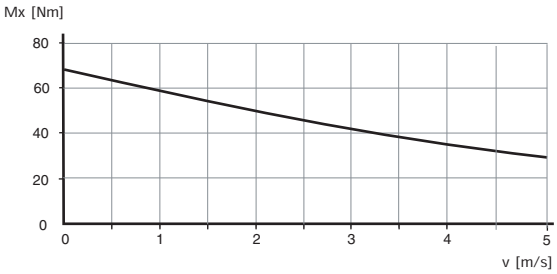
PAS44BB characteristic curves

Max. feed force Fx_{dynmax}

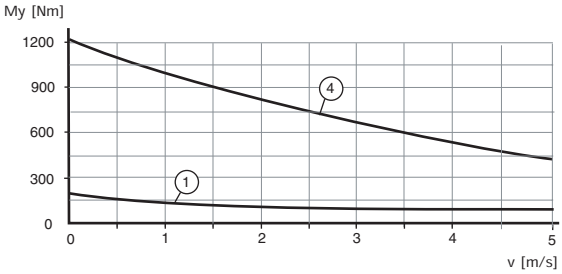


Max. torque Mx_{dynmax}

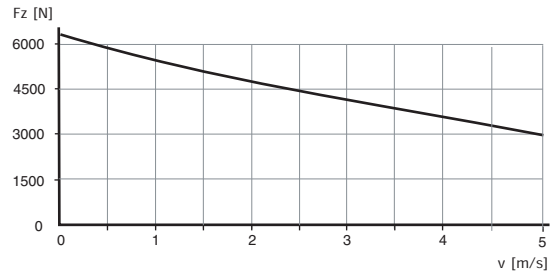


Max. force Fy_{dynmax}

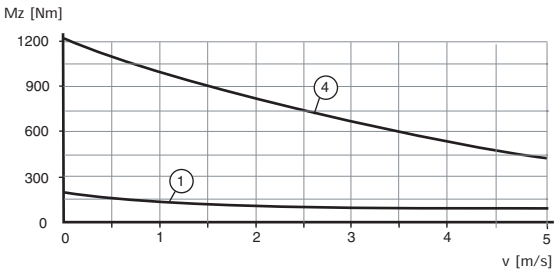
Max. torque of carriage My_{dynmax}



Max. force Fz_{dynmax}

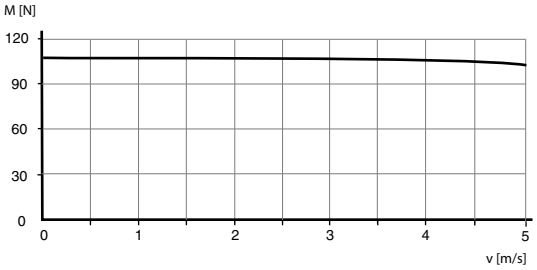


Max. torque of carriage Mz_{dynmax}



(1) Carriage type 1
(4) Carriage type 4

Max. driving torque M_{max}



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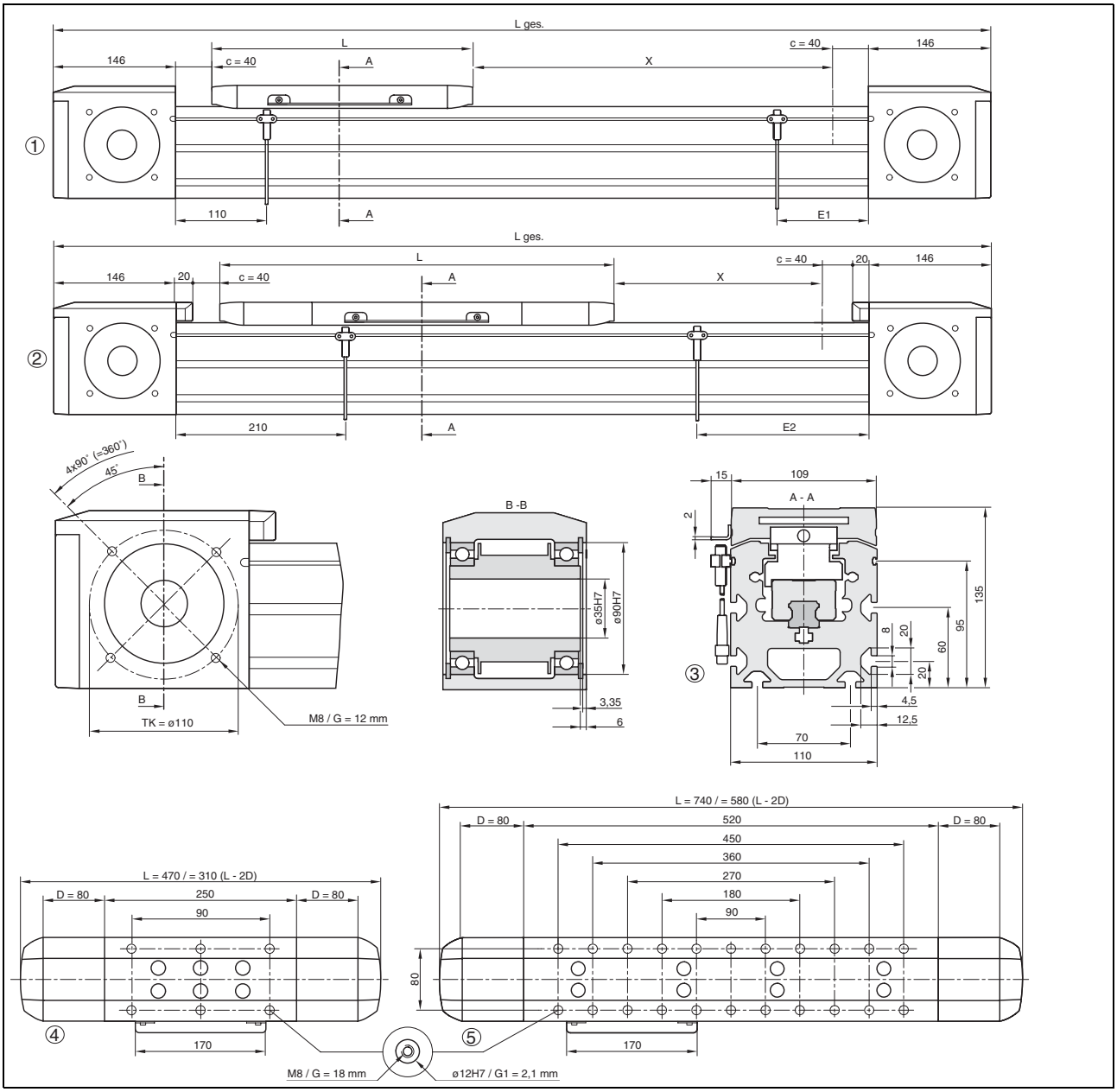

Figure 3.8 Dimensional drawings PAS44B

(1) = axis without cover strap	L total without cover strap = 372 + L + X (per additional carriage: + L + m)
(2) = axis with cover strap	L total with cover strap = 412 + L + X (per additional carriage: + L + m)
(3) = cross section with recirculating ball bearing guide	L = carriage length with cover strap (without cover strap: L - 2D)
(4) = carriage type 1	x = working stroke
(5) = carriage type 4	m = minimum distance between 2 carriages with cover strap 135 mm, without cover strap 55 mm
	c = limit switch safety distances to the mechanical stop
	D = cover strap turning block
G = thread depth	E1 = carriage type 1: with cover strap 210 mm, without cover strap 110 mm
G1 = insertion depth	E2 = carriage type 4: with cover strap 480 mm, without cover strap 380 mm

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3.2.5 Standard tightening torques

Special tightening torques are applicable for mounting sensors, expanding hub, clamping hub, shaft journal etc. They are listed in the specified chapters.

The generally applicable internal hex tightening torques for Allen screws are applicable for mounting motor, gearing, contact plate, T-slot nuts, clamping claws, threaded holes in the carriage, strap turning block etc.

Thread	Wrench size [mm]	$M_{Amax.}$ [Nm]
M3	2.5	1.1
M4	3	2.5
M5	4	5
M6	5	8.5
M8	6	21
M10	8	42
M12	10	70

Table 3.1 Maximum tightening torques for screws, ISO 4762 - 8.8

3.2.6 T-slot nuts

All specified T-slot nuts are made of galvanised steel.

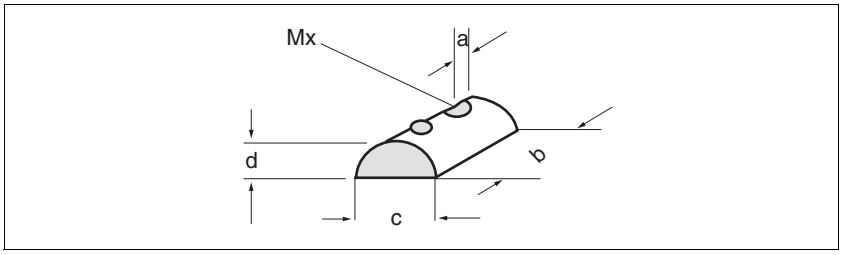

Figure 3.9 Outline drawing of T-slot nuts

Designation		5 x M5	6 x M6	8 x M6	8 x M8
Series (slot width)		5	6	8	8
Thread		M5	M6	M6	M8
Weight m	[g]	2	4	10	10
a	[mm]	4	5.5	6.5	7.5
b	[mm]	11.5	17	23	23
c	[mm]	8	10.6	13.8	13.8
D	[mm]	4	6.4	7.3	7.3

Table 3.2 T-slot nuts, characteristics and dimensions

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3.2.7 Coupling assembly

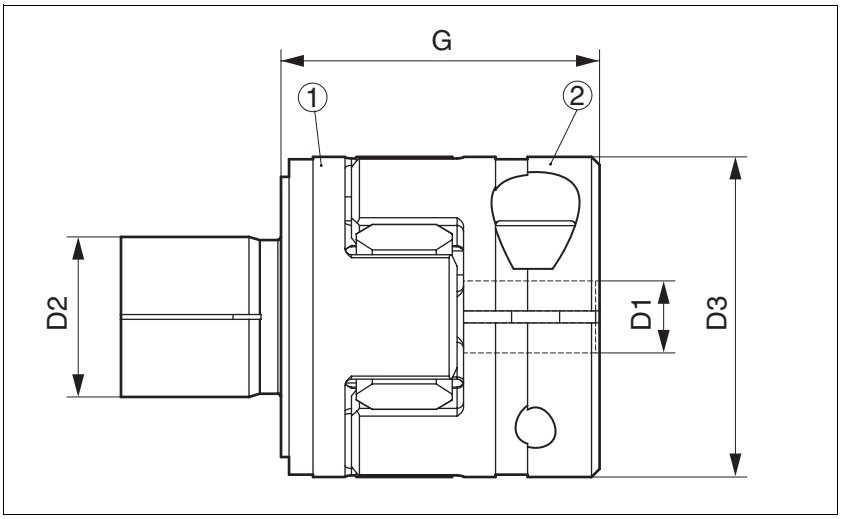

Figure 3.10 Outline drawing of expanding hub (1) and clamping hub (2)

			Expanding hub PAS41	Expanding hub PAS42	Expanding hub PAS43	Expanding hub PAS44
Moment of inertia	$J_{rot.}$	[kgcm^2]	0.009	0.09	0.32	0.77
Fastening screw ISO 4762			M4	M6	M8	M10
Wrench size		[mm]	3	5	6	8
Tightening torque		[Nm]	2.9	10	25	49
Diameter of expanding hub	D2	[mm]	10	20	25	35
External diameter	D3	[mm]	25	40	55	65
Block size	G	[mm]	28	41	46	49

			Clamping hub PAS41	Clamping hub PAS42	Clamping hub PAS43	Clamping hub PAS44
Moment of inertia (smallest hole diameter)	$J_{rot.}$	[kgcm^2]	0.015	0.15	0.55	1.22
Fastening screw ISO 4762			M4	M5	M6	M8
Wrench size		[mm]	3	4	5	6
Tightening torque		[Nm]	1.9	14	14	35
Diameter	D3	[mm]	25	40	55	65

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3.2.8 Toothed belt

Size	Toothed belt pitch width	Specific belt weight		Specific spring rate		Pretension force at 0.1% elongation	
PAS41	3-15	[g/m]	32	[N]	$0.145 * 10^6$	[N]	145
PAS42	5-25	[g/m]	96	[N]	$0.572 * 10^6$	[N]	572
PAS43	5-30	[g/m]	118	[N]	$0.672 * 10^6$	[N]	672
PAS44	8-50	[g/m]	311	[N]	$1.917 * 10^6$	[N]	1917
PAS41	3-15, antistatic	[g/m]	32	[N]	$0.145 * 10^6$	[N]	145
PAS42	5-25, antistatic	[g/m]	96	[N]	$0.572 * 10^6$	[N]	572
PAS43	5-30, antistatic	[g/m]	114	[N]	$0.672 * 10^6$	[N]	672
PAS44	8-50, antistatic	[g/m]	316	[N]	$1.917 * 10^6$	[N]	1917

3.2.9 Shaft journal

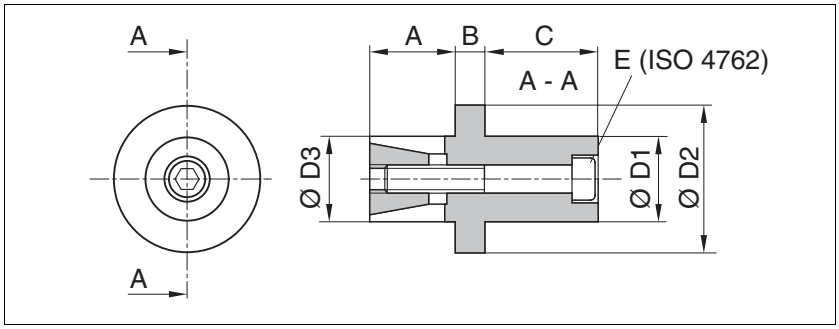

Figure 3.11 Outline drawing of shaft journal

			PAS41 shaft journal	PAS42 shaft journal	PAS43 shaft journal	PAS44 shaft journal
Max. torque	$TR_{max.}$	[Nm]	7.7	35.7	82	182
Max. radial force	$FR_{max.}$	[N]	230	400	700	1300
Moment of inertia	$J_{rot.}$	[$kgcm^2$]	0.002	0.05	0.16	0.54
Fastening screw ISO 4762	E		M4	M6	M8	M10
Wrench size		[mm]	3	5	6	8
Tightening torque		[Nm]	2.9	10	25	49
Fit length	A	[mm]	12	27	32	37
Length of collar	B	[mm]	5.5	7	7.5	9
Installed length	C	[mm]	14	20	30	36
Diameter of shaft journal	D1	[mm]	12	20	25	32
Diameter	D2	[mm]	17	35	45	55
Diameter of expanding hub	D3	[mm]	10	20	25	35

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3.3 Electrical Data

3.3.1 Motor

For more information please see the motor manual.

3.3.2 Sensors

Four types of sensors (limit switches and reference switches) with the following outputs are available:

- PNP/NC (Normally Closed) - normally closed contact
- NPN/NC (Normally Closed) - normally closed contact
- PNP/NO (Normally Open) - normally open contact
- NPN/NO (Normally Open) - normally open contact

Technical data for all types		
Model		Cylindrical thread M8 x 1
Approvals		CE
Electrical connection (PUR cable with M8 connector)	[m]	0.10
Nominal switching distance Sn (with steel)	[mm]	1.5
Assured switching distance (with steel)	[mm]	0 ... 1.2
Hysteresis		1 to 15% of the actual switching distance
Degree of protection as per IEC 60529		IP67
Temperature (storage)	[°C]	-40 ... +85
Temperature (operation)	[°C]	-25 ... +70
Material of housing		Nickel-plated brass
Material of cable		PUR, 3 x 0.12 mm^2, length 10 cm
Oscillation stress as per IEC 60068-2-6		25gn, amplitude ±2 mm (f = 10 ... 50Hz)
Shock stress as per IEC 60068-2-27		50gn, duration 11 ms
Output function display		Yellow LED
Operating voltage function display		No
Supply voltage (PELV)	[V_{DC}]	12 ... 24 with reverse polarity protection
Operating voltage (incl. residual ripple)	[V_{DC}]	10 ... 36
Switching current (overload and short-circuit protection)	[mA]	< 200
Voltage drop, output force-tripped	[V]	< 2
No-load current	[mA]	< 10
Maximum switching frequency	[Hz]	5000
Time delay before availability	[ms]	< 10
Make time	[ms]	< 0.1
Break time	[ms]	< 0.1

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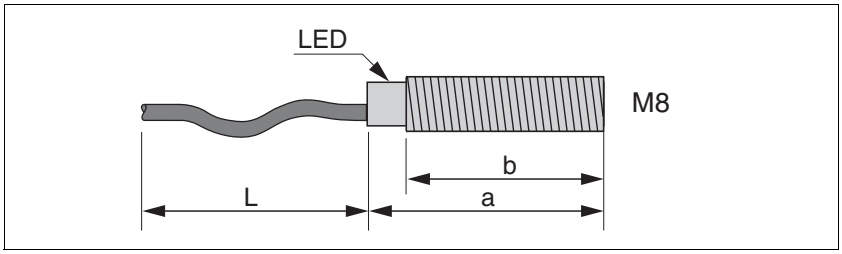

Figure 3.12 Outline drawing of sensor

a	[mm]	33
b	[mm]	25
L	[mm]	100

For information on the terminal assignment see chapter 5.3.1 "Connection of sensors".

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4 Engineering

This chapter contains basic information on options for use of the product, which are essential for the engineering.

The specified technical parameters and the maintenance intervals must be observed to ensure safe and reliable continuous operation. See chapter 9.2 "Maintenance".

▶ The maintenance intervals must be included in the system maintenance schedule.

The linear axis is designed for use in continuous operation. The service life must be calculated case by case based on the application.

4.1 Selection criteria for the guideway system

Roller guide

- smooth running with optimum running characteristics
- low noise with quiet running characteristics
- long stroke lengths applicable without difficulty
- economical alternative to recirculating ball bearing guide

Recirculating ball bearing guide

- high load capacity of guideway
- high guideway accuracy
- high torque acceptance with optimum force application to section

4.2 Cantilever principle

The linear axis can also be used as a cantilever axis (carriage fixed, axial section moves).

Note that the moving mass is increased because the axial section, motor and power supply must also be moved with the axis.

4.3 Toothed-belt drive gear

The drive can be attached with backlash-free belt drive gear to save space. The drive gear can be oriented horizontally, left and right and also vertically upwards and downwards.

4.4 Support axis

A support axis carries loads that are applied asymmetrically to the carriage and improves the stability and service life of the system. The support axis does not have its own drive elements.

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4.5 Sensors

Position of limit switches The travel between limit switches and the end block must be sufficient for the braking distance.

Limit switch type Your controller interfaces must be suitable for the limit switches and reference switches.

⚠ WARNING

Loss of control over controller

If unsuitable limit switches are installed, earth faults or line break will be detected as On status and will cause failure of the protection function.

- For protection against line break and earth fault use only sensors of the "normally closed contact" and “PNP” (sink) types as limit switches.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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5 Installation

The chapter on engineering contains basic information that you should know before starting the installation.

⚠ WARNING

Risk of injury by heavy weight, falling parts or crushing!

- Take the weight of the axis into account during mounting. It may be necessary to use a crane.
- Install the threaded fasteners (torque, screw locking) to ensure that axis and attachments do not come apart even under strong accelerations or continuous vibration.
- Note that axes subject to external forces (vertical axes) may drop unexpectedly.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING

Danger of injury and damage to system components by unbraked motor!

Loss of power or faults that result in switching off the power amplifier mean that the motor is no longer actively braked and may run against a mechanical stop at high speed.

- Check the mechanical conditions.
- If necessary, use an absorbent mechanical stop or a suitable brake.

Neglect can result in an accident or damage to the system

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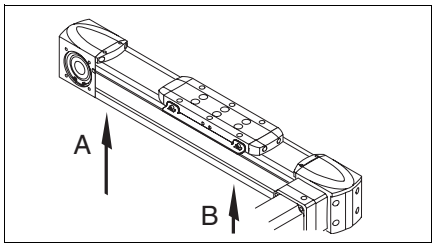
5.1 Preparation of installation

Linear axes are precision products and must be handled carefully. Shocks and impacts on the carriages may damage the guideways. This may cause inaccuracies in the guideway travel and even premature failure.

Transport the linear axis in its packaging as close as possible to the installation site. Do not remove the packaging until the axis is at the installation site.



The linear axis must only be lifted in the specified range A and B (see figure). The distance from the end blocks should be approx. ¼ of the total length of the linear axis.

In the case of a linear axis with motor it must not be used as a load-holding point. However, the motor may be held to steady the load.

5.2 Mechanical installation

Accessibility for service

When mounting the linear axis, motor and sensors make sure that they are accessible for service.

Mounting position

The linear axis can be installed in any position.

If a linear axis with attached motor is mounted in a vertical position, the motor should be at the top.

This reduces the loads on the bearings.

If the axis is used as a cantilever axis (carriage fixed, axial section moves), the motor should be at the bottom because of the above reason.

5.2.1 Attachment of the linear axis

To attach the linear axis the specified T-slots on the axial section only must be used. Use the applicable T-slot nuts (bottom or on the side) of clamping claws (side), as specified in chapter 8 "Accessories and spare parts".

Note the following in particular:

- When using motors with a larger cross section than the axial section the axis must be supported or the clamping surface must be cut out as required.
- The end blocks are larger than the axial section. This must be taken into account on the clamping surface.
- If the side slots are used for fastening, in some circumstances the sensor cable cannot be completely installed in the slots.

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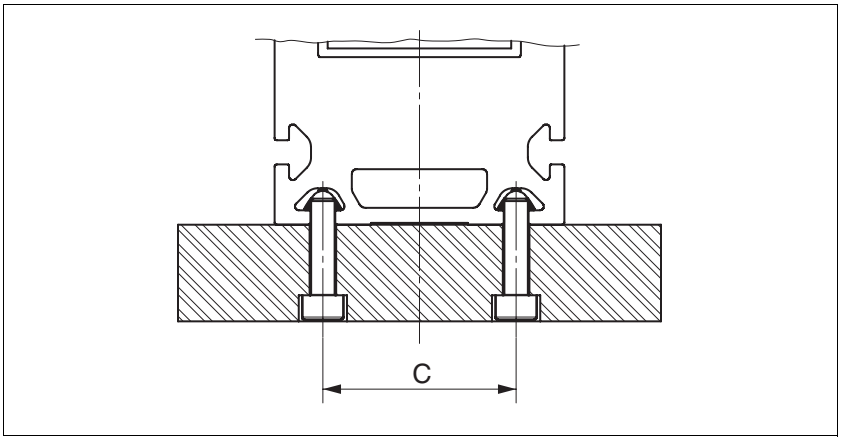

Figure 5.1 Fastening with T-slot nuts

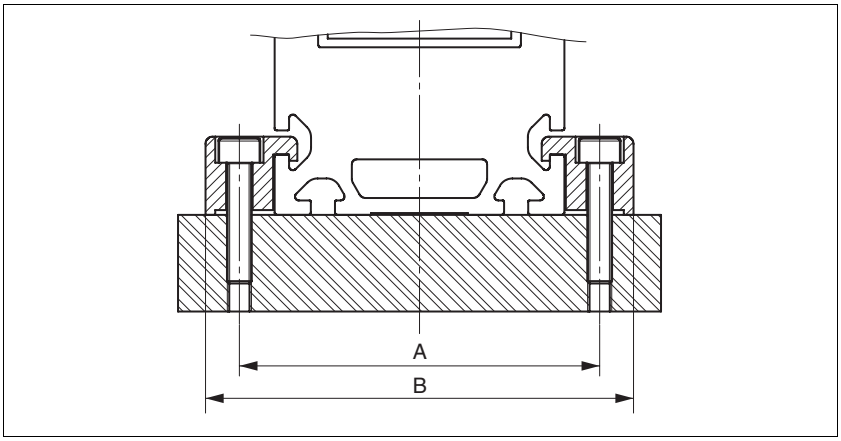

Figure 5.2 Fastening with clamping claws

Hole distance		PAS41	PAS42	PAS43	PAS44
A	[mm]	54	74	96	130
B	[mm]	68	88	112	150
C	[mm]	20	40	50	70

The greater the load or the demands on the sequence accuracy the shorter the distance between the T-slot nuts or the clamping claws must be.

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Orientation with reference to sequence accuracy

Because of the manufacturing process of the extruded profiles linear axes tend to have variations in straightness and twist. The permissible variations are generally well within the specifications of EN 12020-2 with PAS linear axes.

The guideway has a precision of ±0.02 mm in relationship to the outside of the axial section. The outside is marked by a groove in the side slot. Use this side for orientation of the axis.

The linear axis can be aligned as follows with reference to the side sequence accuracy. The clamping surface must be machined smooth and flat.

- ▶ Fasten the fastening screws of the T-slot nuts or the clamping claws lightly.
- ▶ Measure the variations over the complete stroke with a measuring probe while traversing the carriage manually.
- ▶ Tighten the fastening screws one by one to correct the variations and align the linear axis.

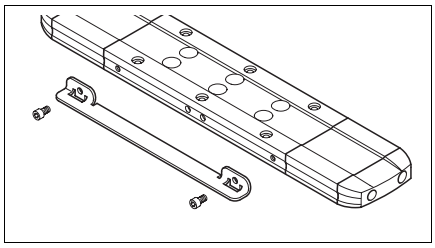
5.2.2 Mounting contact plate and sensor with alignment

Inductive sensors are used as limit switches and reference switches. Check the sensor type.

- ■ You need a set of Allen keys, a feeler gauge, the sensor retainer and the sensor.

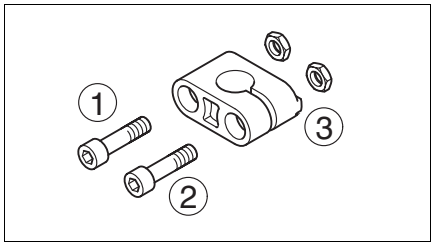
A sensor is fastened to the axial section with a retainer. There is a T-slot in the axial section with milled slots in both end blocks for insertion of the fastening screws to hold the retainer.

Mounting contact plate



The contact plate for the inductive sensors must be mounted on the carriage. There are threaded holes for fastening on both sides of the carriage.

- ▶ For mounting select the side of the carriage that will be easily accessible for service.
- ▶ Screw the contact plate to the carriage with M4 screws (see figure).

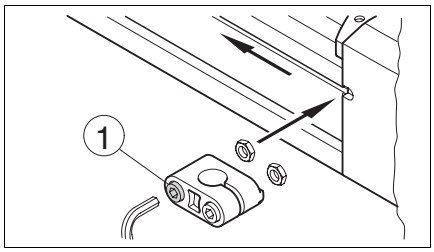


Mounting retainer

There are two M3 Allen screws with Allen nuts on the retainer.

- Fasten the retainer in the slot with the screw (1).
- The sensor is fastened to the retainer with the screw (2).

There is also a cam (3) on both sides of the retainer to prevent the retainer from rotating in the T-slot.

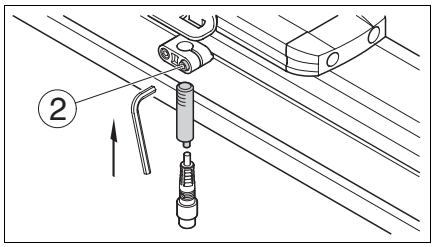


▶ Slide the nuts singly to the milled section in the T-slot.

▶ Position the retainer with the two screws. Leave the two screws loose at first.

▶ Slide the retainer to the desired position and tighten the screw (1) to a torque of 0.3 Nm.

Alignment of sensor



Because the sensors are inductive, a distance from the contact plate is required when mounting the sensor. This "switching distance" for PAS linear axes is 0.5 ±0.1 mm.

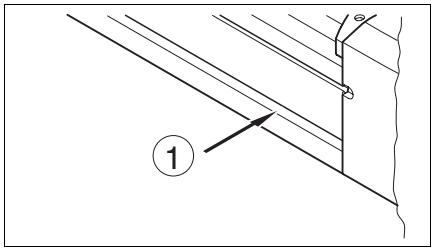
▶ Traverse the carriage until the contact plate is under the sensor retainer.

▶ Slide the sensor through the retainer opening until the switching distance of sensor and contact plate has been reached. Check the distance with a feeler gauge.

▶ Tighten the screw (2).

▶ Finally check the "switching distance" with the feeler gauge again.

Layout of sensor cables



The slot (1) can hold up to 3 sensor cables. Suitable slot covers are available on request.

5.2.3 Mounting motor or gearing

Unless otherwise specified in the text, the standard tightening torques listed in chapter 3.2.5 "Standard tightening torques" are applicable.

Clamping hub		PAS41	PAS42	PAS43	PAS44
Fastening screw ISO 4762		M4	M5	M6	M8
Wrench size	[mm]	3	4	5	6
Tightening torque	[Nm]	1.9	14	14	35

Table 5.1 Tightening torques for clamping hubs

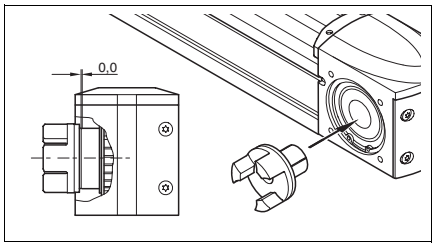
Expanding hub		PAS41	PAS42	PAS43	PAS44
Fastening screw ISO 4762		M4	M6	M8	M10
Wrench size	[mm]	3	5	6	8
Tightening torque	[Nm]	2.9	10	25	49

Table 5.2 Tightening torques for expanding hubs

The motor can be mounted to either side of the two end blocks. The motor is mounted on a backlash-free coupling.

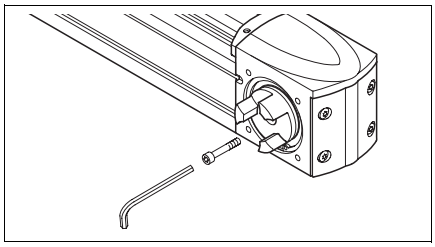
Unless included in the scope of supply, appropriate couplings and motor adapter plates (also for gearing) can be found in chapter 8 "Accessories and spare parts".

- ▶ Clean all parts before assembly. Check all parts for damage and discard damaged parts. Otherwise concentricity errors may occur, which will affect the service life of the coupling and the linear axis.
- ▶ Slide the expanding hub on to the hollow shaft of the gear wheel until it sits flat against it.



- ▶ Tighten the fastening screw (tightening torque see Table 5.2).

  The gear wheel is prevented from rotating when the carriage is at the final position.



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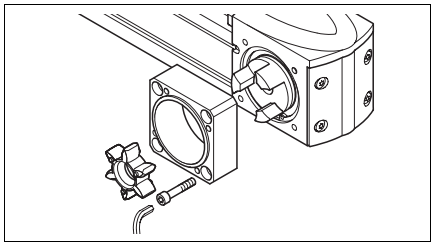
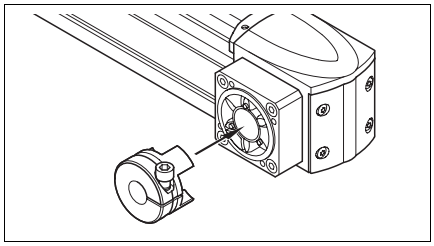


- Position the ring gear.

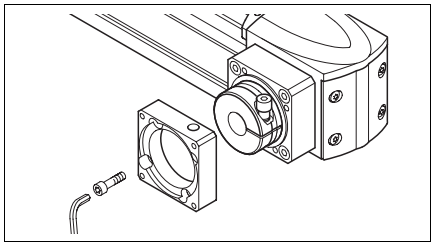
  The ring gear can move axially to compensate for axial displacement of the shafts.
- Mount the coupling housing with the four screws. Make sure that it is positioned flat.



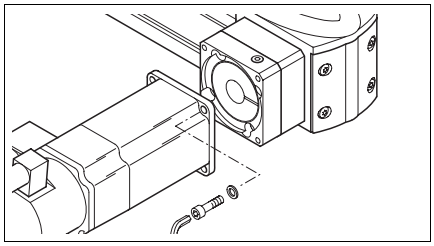
- Position the clamping hub (not too far). Note the size of the block on page 3-21.

  Check the orientation of the clamping screw (preferably upwards). The clamping screw is tightened later through the hole in the motor adapter plate.

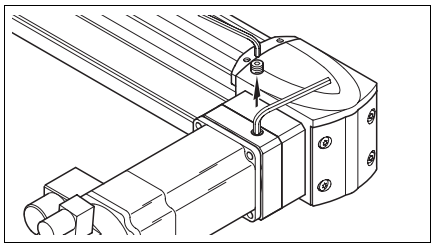
Installation of motor only



- Position the motor adapter plate flat. Check the position of the side hole through which you can tighten the clamping hub screw.
- Tighten the four screws.

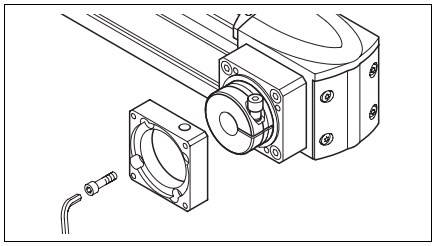


- Position the motor flat. Secure the motor to prevent its falling. If possible, position the linear axis so the motor will be vertically upwards when installed.
- If the motor has a parallel keyway position it on the slot of the clamping hub to prevent concentricity errors.
- Tighten the four screws with washers.

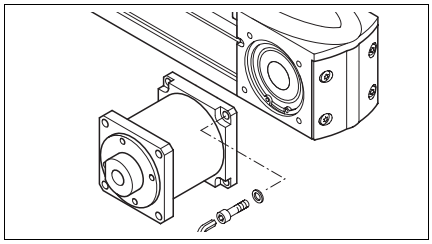


- Remove the screw plug in the side hole of the motor adapter plate.
- Tighten the fastening screw of the clamping hub through the hole (tightening torque see Table 5.1).
- Close the hole with the screw plug.

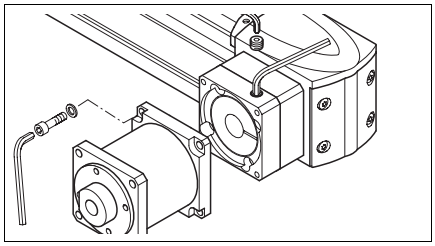
Installation of gearing only



- ▶ Position the motor adapter plate flat. Check the position of the side hole through which you can tighten the clamping hub screw.
- ▶ Tighten the four screws.



- ▶ A flange plate is required for gearing without an installed flange. Mount the flange plate to the gearing with the four screws. Make sure that the flange is positioned flat.



- ▶ Mount the gearing flange (or the flange plate) to the motor adapter plate with the four screws. Make sure that the flange is positioned flat.
- ▶ If the gearing has a parallel keyway position it on the slot of the clamping hub to prevent concentricity errors.
- ▶ Remove the screw plug in the side hole of the motor adapter plate.
- ▶ Tighten the fastening screw of the clamping hub through the hole (tightening torque see Table 5.1).
- ▶ Close the hole with the screw plug.

For the procedure for mounting a motor to the gearing see the corresponding gearing manual.

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5.2.4 Mounting shaft journal

Unless otherwise specified in the text, the standard tightening torques listed on page 3-20 are applicable.

Shaft journal		PAS41B	PAS42B	PAS43B	PAS44B
Wrench size	[mm]	3	5	6	8
Tightening torque	[Nm]	2.9	10	25	49

Table 5.3 Tightening torques for shaft journal

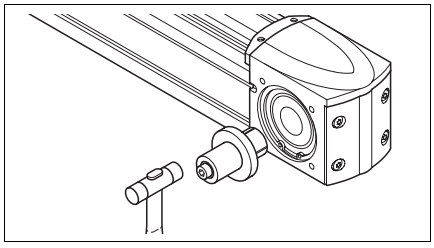
Linear axes with a shaft journal are referred to as shaft axes. A coupling for a motor, belt drive gear or an external encoder can be installed on the shaft journal.

Shaft journals can also be installed later on either end block. For appropriate shaft journals see chapter 8 "Accessories and spare parts".

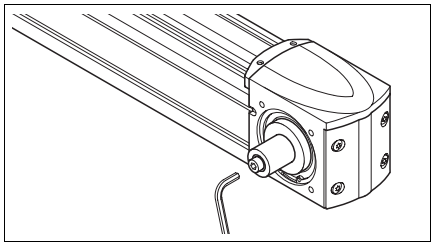
Proceed as follows for mounting:

- ▶ Clean all parts before assembly. Check all parts for damage and discard damaged parts. Otherwise concentricity errors may occur, which will affect the service life of the coupling and the linear axis.
- ▶ Guide the shaft journal into the hollow shaft on the end block until it is flat against the gear wheel.

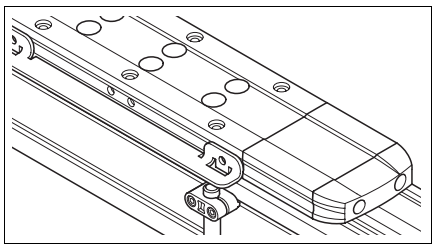
  To fit it in (approx. 2 mm), it may be necessary to tap the shaft lightly with a plastic hammer (not on the screw head).



- ▶ Tighten the screw (tightening torque see Table 5.3).



5.2.5 Mounting customer application on carriage



There are threaded holes for an application interface on the top of the carriage.

Every threaded hole has an indentation for inserting a locating dowel for centring. For appropriate locating dowels see chapter 8 "Accessories and spare parts".

Threaded hole		PAS41	PAS42	PAS43	PAS44
Thread		M5	M5	M6	M8
Depth	[mm]	10	10	12	16
Locating dowel	[mm]	8	8	10	12

5.3 Electrical installation

5.3.1 Connection of sensors

The sensors are fitted with a M8 x 1 connector.

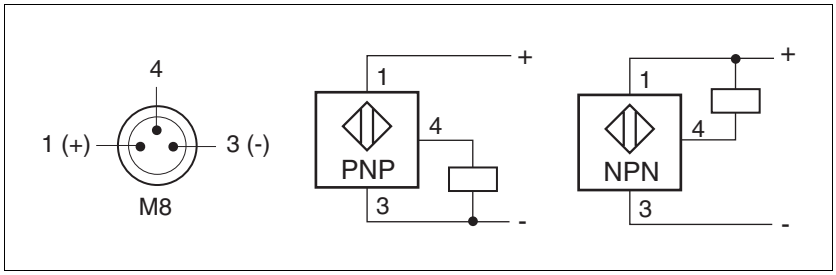


Figure 5.3 M8 pin assignment for sensors

Pin	Description	Colour
1	PELV supply voltage (+)	BN (brown)
3	PELV supply voltage (-)	BU (blue)
4	Output	BK (black)

The cable length is 100 mm. Extension cables with sockets are available in various lengths as accessories, see chapter 8 "Accessories and spare parts".

5.3.2 Motor connection

For more information please see the motor manual.

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5.4 Checking installation

After completion of all steps we recommend checking the installation to prevent any errors before operation of the system.

▶ Make sure the drive system is correctly installed and wired up. Check in particular basic connections such as mains supply and 24V power supply.

▶ Check in detail:

- Are all protective conductors connected?
- Are all fuses correct?
- Are any live cable ends exposed?
- Are all cables and connectors safely installed and connected?
- Are the sensors correctly mounted?
- Can the carriage with the sensor contact plate be traversed freely over the complete path?
- Do the sensors function?

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6 Commissioning

6.1 General safety instructions

⚠ WARNING

Unexpected movements may cause injury and damage to the system

When the axis is operated for the first time there is a high risk of unexpected movements because of possible wiring errors or unsuitable parameters.

- Check that the axis is securely fastened so it cannot break loose even under strong acceleration.
- Note that axes subject to external forces (vertical axes) may drop unexpectedly.
- Make sure that a functioning button for EMERGENCY STOP is within reach.
- Make sure that the system is free and ready for movement before switching it on.
- Conduct the initial test movements at a reduced speed.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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6.2 Commissioning procedure

The following commissioning steps are also required if you are using a configured unit under changed operating conditions.

- ▶ Check the function of the limit switch. The integrated LED must display the switching status correctly.
- ▶ Before operation make sure that the loads that are actually applied conform to the required and planned data.
- ▶ Conduct the initial test movements at a reduced speed. During testing check that the controller reacts correctly to the limit switches in both directions of travel.
- ▶ Check the distance of the limit switches to the mechanical stops. The movement must be stopped by the limit switches before the carriage reaches the mechanical stop.
- ▶ Make sure that the limit switches are positioned with reference to the position of the carriage so the movements are actually limited by a limit switch in both directions.
- ▶ Run a complete test under realistic conditions.

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7 Diagnostics and troubleshooting

7.1 Troubleshooting

Malfunction	Cause	Correction
The carriage overruns the limit switch	Limit switch is faulty	Replace limit switch, page 9-5
	Error in controller	Correct error
Motor load increases, controller switches off because of overload.	Guideways distorted or excessive friction caused by poor lubrication.	Contact service
Noise generation and vibrations during operation of the linear axis at high speeds.	Speed too high	Reduce speed
	Poor lubrication (with noise generation)	Lubricate, page 9-2
Travel accuracy and noise generation on guideways.	Poor lubrication	Lubricate, page 9-2
	Damage to guideways, e.g. by shock or impact on the carriage.	Guideways must be replaced. Contact service
Carriage has play and positions inaccurately.	Play in guideways after a crash or poor lubrication	contact service

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8 Accessories and spare parts

If you do have any order numbers and if you have any questions please contact your local dealer.

8.1 Shaft journal

for size	Description	Order number
PAS41	Shaft journal 12 x 12 / 14 x 10	MNA3MF1S12A12
PAS42	Shaft journal 27 x 20 / 20 x 20	MNA3MF1S27A20
PAS43	Shaft journal 32 x 25 / 30 x 25	MNA3MF1S32A25
PAS44	Shaft journal 37 x 32 / 36 x 35	MNA3MF1S37A32

8.2 Expanding hub

for size	Description	Order number
PAS41	Expanding hub 10 x 14 / 25 x 16	MNA3MFSC10A14
PAS42	Expanding hub 20 x 20 / 40 x 22	MNA3MFSC20A20
PAS43	Expanding hub 25 x 30 / 55 x 24	MNA3MFSC25A30
PAS44	Expanding hub 35 x 36 / 65 x 25.5	MNA3MFSC35A36

8.3 Clamping hub

for size	Description	Order number
PAS41	Clamping hub 6.35 x 5.5 / 25 x 12	MNA3MFCC06A06
	Clamping hub 8 x 5.5 / 25 x 12	MNA3MFCC08A06
	Clamping hub 9 x 5.5 / 25 x 12	MNA3MFCC09A06
	Clamping hub 10 x 5.5 / 25 x 12	MNA3MFCC10A06

for size	Description	Order number
PAS42	Clamping hub 6.35 x 7 / 40 x 27	MNA3MFCC06A07
	Clamping hub 8 x 7 / 40 x 27	MNA3MFCC08A07
	Clamping hub 9 x 7 / 40 x 27	MNA3MFCC09A07
	Clamping hub 10 x 7 / 40 x 27	MNA3MFCC10A07
	Clamping hub 11 x 7 / 40 x 27	MNA3MFCC11A07
	Clamping hub 12 x 7 / 40 x 27	MNA3MFCC12A07
	Clamping hub 14 x 7 / 40 x 27	MNA3MFCC14A07
	Clamping hub 16 x 7 / 40 x 27	MNA3MFCC16A07

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for size	Description	Order number
PAS43	Clamping hub 9 x 7.5 / 55 x 32	MNA3MFCC09A08
	Clamping hub 11 x 7.5 / 55 x 32	MNA3MFCC11A08
	Clamping hub 12 x 7.5 / 55 x 32	MNA3MFCC12A08
	Clamping hub 14 x 7.5 / 55 x 32	MNA3MFCC14A08
	Clamping hub 19 x 7.5 / 55 x 32	MNA3MFCC19A08
	Clamping hub 20 x 7.5 / 55 x 32	MNA3MFCC20A08
	Clamping hub 22 x 7.5 / 55 x 32	MNA3MFCC22A08

for size	Description	Order number
PAS44	Clamping hub 12 x 9 / 65 x 37	MNA3MFCC12A09
	Clamping hub 14 x 9 / 65 x 37	MNA3MFCC14A09
	Clamping hub 19 x 9 / 65 x 37	MNA3MFCC19A09
	Clamping hub 20 x 9 / 65 x 37	MNA3MFCC20A09
	Clamping hub 22 x 9 / 65 x 37	MNA3MFCC22A09
	Clamping hub 23 x 9 / 65 x 37	MNA3MFCC23A09
	Clamping hub 24 x 9 / 65 x 37	MNA3MFCC24A09

8.4 Ring gear for coupling subassembly

for size	Description	Order number
PAS41	Ring gear 9 mm	MNA3MFR09A018
PAS42	Ring gear 14 mm	MNA3MFR14A034
PAS43	Ring gear 20 mm	MNA3MFR20A120
PAS44	Ring gear 25 mm	MNA3MFR25A320

8.5 Clamping claws

for size	Description	Order number
PAS41	10 units clamping claws slot size NG 5 76 x 18 x 11.2	MNA3MF10/5/11
PAS42	10 units clamping claws slot size NG 5 76 x 19 x 16.2	MNA3MF10/5/12
PAS43	10 units clamping claws slot size NG 6 76 x 24 x 21.5	MNA3MF10/6/13
PAS44	10 units clamping claws slot size NG 8 76 x 28 x 22	MNA3MF10/8/14

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8.6 T-slot covers

for size	Description	Order number
PAS41	2m long, slot size 5, 5 units	MNA3MC05A05
PAS42	2m long, slot size 5, 5 units	MNA3MC05A05
PAS43	2m long, slot size 6, 5 units	MNA3MC05A06
PAS44	2m long, slot size 8, 5 units	MNA3MC05A08

8.7 T-slot nuts

for size	Description	Order number
PAS41	Size 5 with M5 hole, 10 units	MNA3MF010T5N5
PAS42	Size 5 with M5 hole, 10 units	MNA3MF010T5N5
PAS43	Size 6 with M6 hole, 10 units	MNA3MF010T6N6
PAS44	Size 8 with M6 hole, 10 units	MNA3MF010T8N6
PAS44	Size 8 with M8 hole, 10 units	MNA3MF010T8N8

8.8 Sensors

Sensors with signal display with 100 mm cable and 3-pin M8 circular plug-in connector.

The extension cables are suitable for trailing cables. They are fitted with M8 circular plug-in connector 3-pin female connectors at one end. The other end is open.

Designation	Description	Order number
Sensor	M8 PNP normally closed contact	XS508B1PBP01M8
Sensor	M8 NPN normally closed contact	XS508B1NBP01M8
Sensor	M8 PNP normally open contact	XS508B1PAP01M8
Sensor	M8 NPN normally open contact	XS508B1NAP01M8
Sensor retainer	Sensor retainer for M8 sensors, T-slot 3 mm, with screws and nuts, 10 units	MNA3MF010M8
Extension cable	length 5 m	MNA2SBCBGA050
Extension cable	length 10 m	MNA2SBCBGA100
Extension cable	length 20 m	MNA2SBCBGA200

8.9 Locating dowels

for size	Description	Order number
PAS41	Locating dowel D08, 10 units	MNA3MF020LD01
PAS42	Locating dowel D08, 10 units	MNA3MF020LD01
PAS43	Locating dowel D10, 10 units	MNA3MF020LD02
PAS44	Locating dowel D12, 10 units	MNA3MF020LD03

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8.10 Lubrication

The grease guns listed in the table below are supplied without a nozzle. The nozzles must be ordered separately.

Designation	Description	Order number
Oil gun for lubrication of roller guides	Single-hand high-pressure oil gun 120 cm^3 capacity 120 cm^3 ; delivery 0.5 cm^3 / stroke operating pressure 400 bar; for application of mineral oils	MNA3MAP02
Grease gun for lubrication of recirculating ball bearing guide	Single-hand high-pressure grease gun 120 cm^3 capacity 120 cm^3 ; delivery 0.5 cm^3 / stroke operating pressure 400 bar;	MNA3MAP01
Nozzle D6 nipple D 20 degree	Nozzle ∅ 6 mm curved model; length L = 200 mm; with M4 pointed tip for type D lubrication nipple; nozzle can be swivelled 360° around its own axis.	MNA3MAT02
Nozzle D6 nipple D 90 degree	Nozzle ∅ 6 mm straight model; length L = 200 mm; with M4 pointed tip - 90° to side for type D lubrication nipple; nozzle can be swivelled 360° around its own axis.	MNA3MAT01

8.11 Product manual

Description	Order number
Product manual for PAS4xB belt axes, DE	MNA1MLBDM00DE
Product manual for PAS4xB belt axes, EN	MNA1MLBDM00EN
Product manual for PAS4xB belt axes, IT	MNA1MLBDM00IT
Product manual for PAS4xB belt axes, FR	MNA1MLBDM00FR
Product manual for PAS4xB belt axes, ES	MNA1MLBDM00ES

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9 Service, maintenance and disposal

⚠ DANGER

Electric shock

High voltages at the motor connection may occur unexpectedly.

- Make sure that the drive (including DC bus) is disconnected from power before working on the drive system
- AC voltages may jump over unused wires in the motor cable. Isolate unused wires at both ends of the motor cable.
- The motor generates voltage when the shaft is rotated. Lock the motor shaft to prevent rotation before starting work on the drive system.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

Risk of injury by heavy weight, falling parts or crushing!

- Take the weight of the axis into account during mounting. It may be necessary to use a crane.
- Install the threaded fasteners (torque, screw locking) to ensure that axis and attachments do not come apart even under strong accelerations or continuous vibration.
- Note that axes subject to external forces (vertical axes) may drop unexpectedly.

Failure to follow these instructions can result in death, serious injury or equipment damage.

9.1 Service address

If you cannot resolve the fault yourself please contact your appointed sales partner. Have the following details available:

- Type, identification number and serial number of the product (type plate)
- Type of fault (possibly with fault number)
- Previous and concurrent conditions
- Your own ideas regarding the cause of the fault

Include this information if you return the product for inspection or repair.

If you have any questions please contact your local dealer.
Your dealer will be happy to give you the name of a customer service outlet in your area.

http://www.berger-lahr.com

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9.2 Maintenance

9.2.1 Cleaning

Because of its design the linear axis resists penetration of dirt and foreign bodies. The guideway is internal and is covered.

The linear axis must be regularly inspected and, if necessary, cleaned to keep it functioning and to ensure its operating reliability over the long term.

- ▶ Do not use compressed air for cleaning.
- ▶ Clean large particles and pieces of dirt from the surface regularly.
- ▶ The anodised surface has only limited resistance to alkaline cleaning agents. Use only neutral cleaning agents for cleaning.
- ▶ Use only damp, soft and lint-free cleaning cloths to wipe the surface.

Cover strap The cover strap must be cleaned regularly and coated with a thin film of lubricant to protect it against corrosion.

9.2.2 Lubrication

⚠ CAUTION

The product may be damaged by use of incorrect lubricants.

If the guide type of a toothed belt axis is not noted the incorrect lubricant may be used.

- Note the type code.

Failure to follow these instructions can result in equipment damage.

Lubricant is used continuously during operation of the linear axis. Regular lubrication throughout the service life is essential for reliable operation.

Insufficient lubrication or the incorrect lubricant will increase wear and reduce the service life. The following factors influence the lubrication intervals:

- dust
- high operating temperatures
- heavy loads
- high oscillation load
- permanent small strokes

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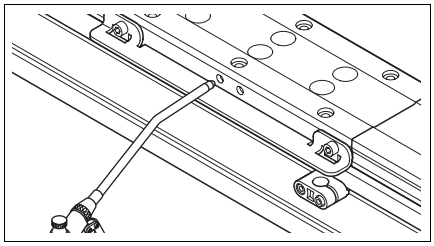
9.2.3 Lubrication with roller guide



The linear axis with roller guide (PASxxB**R**) is fitted with external lubrication for oil. It is filled at the factory. There are two flush-type lubrication nipples on each side of the carriage. The guide rods of the rollers are lubricated and cleaned by oil-bath, sprung lubrication elements.

The lubrication interval depends on the load, speed, cycle time, environment etc. Under normal operating conditions the following value can be used as an approximate value for a lubrication interval.

- 2500 km operational performance

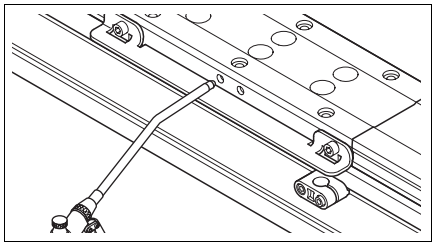
Size	Lubricant	Lubricant quantity	Strokes
PAS41	Lamora D 220	1.25 cm^3	2 1/4
PAS42	Lamora D 220	3 cm^3	6
PAS43	Lamora D 220	4.25 cm^3	8 1/4

When injecting lubricant a maximum flow must not be exceeded. Therefore, every stroke of the oil gun must not be less than 5 seconds. Wait for at least 10 seconds between strokes to allow the oil to penetrate the lubrication elements.

For a suitable oil gun, nozzles and lubricants for normal operating conditions see chapter 8 "Accessories and spare parts".

▶ Inject the correct type and volume of oil into the two lubrication nipples on one side of the carriage.

9.2.4 Lubrication with recirculating ball bearing guide



The linear axis with recirculating ball bearing guide (PASxxB**B**) is fitted with external lubrication for grease. It is filled at the factory. There are two flush-type lubrication nipples on each side of the carriage. The circulating balls are lubricated on the guide rail.

The lubrication interval depends on the load, speed, cycle time, environment etc. Under normal operating conditions the following value can be used as an approximate value for a lubrication interval.

- 5000 km operational performance

Size	Lubricant	Lubricant quantity	Strokes
PAS42	Microlube GL 261	0.3 cm^3	1/4
PAS43	Microlube GL 261	0.6 cm^3	1 1/4
PAS44	Microlube GL 261	1.0 cm^3	2

When injecting lubricant a maximum flow must not be exceeded. Therefore, every stroke of the grease gun must not be less than 3 seconds. The linear axis carriage must be moved between strokes to allow the grease to distribute evenly in the lubricant reservoirs in the guide carriage.

For a suitable grease gun, nozzles and lubricants for normal operating conditions see chapter 8 "Accessories and spare parts".

▶ Inject the correct type and volume of grease into the two lubrication nipples on one side of the carriage.

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9.3 Replacement of parts

Replace only the parts described as required. All other parts can only be replaced by technicians trained by the manufacturer.

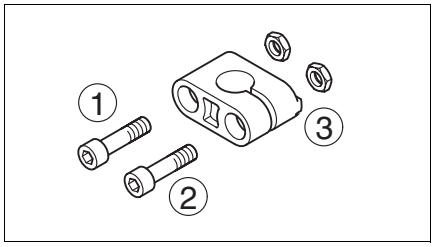
Align and check the axis after replacing parts as described in chapter 6 "Commissioning"

Carry out a complete installation after replacing the complete axis, see chapter 5 "Installation".

Unless otherwise specified in the text, the standard tightening torques listed in chapter 3.2.5 "Standard tightening torques" are applicable.

9.3.1 Replacement of sensor

The sensor can be replaced without changing the position of the retainer.



- You need a set of Allen keys, a feeler gauge and the replacement sensor.

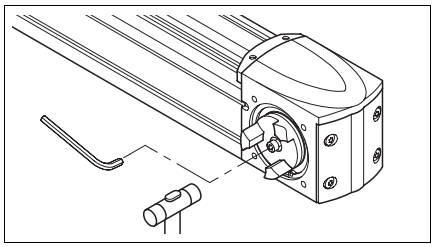
▶ Unscrew the M3 screw (2) on the slotted side of the retainer until the sensor can be pulled out from below.

▶ Mount the new sensor as described in "Alignment" in chapter 5.2.2 "Mounting contact plate and sensor with alignment".

9.3.2 Replacement of motor, gearing or drive shaft

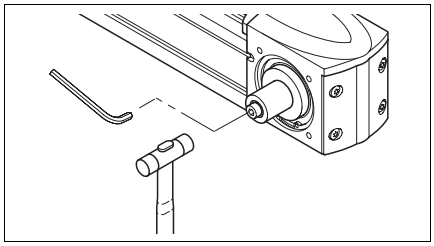
▶ To remove the motor or gearing proceed in reverse order of mounting. See chapter 5.2.3 "Mounting motor or gearing"

Observe the following instructions for removal of the expanding mandrel:



▶ Slacken the fastening screw to remove the expanding mandrel.

▶ Tap the screw head lightly with a plastic hammer to release the internal taper from the expanding mandrel taper. The hub is now loose and be removed easily.



▶ If necessary, remove the drive shaft from the end block. Loosen the screw to do this.

It may be necessary to tap the screw head lightly with a plastic hammer to release the taper.

▶ If applicable, mount the drive shaft as described on page 5-9.

▶ If applicable, mount the motor as described on page 5-6.

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9.3.3 Replacement of cover strap (and turning blocks)

⚠ CAUTION

Risk of injury by sharp edges!

The cover strap has sharp edges. Dangerous sharp edges may be encountered, particularly when cutting.

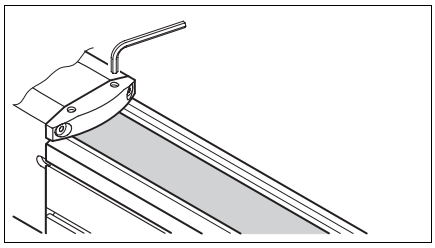
- Wear safety gloves for replacement.

Failure to follow these instructions can result in death or serious injury.

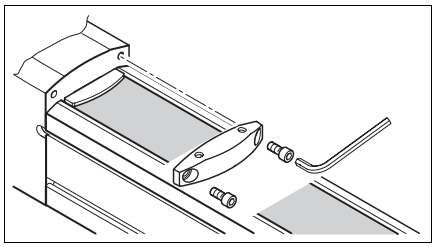
When the cover strap is worn, it is recommended that the two turning blocks be replaced at the same time (plastic unit with wiper only).

Carry all following steps on both sides of the carriage or axis.

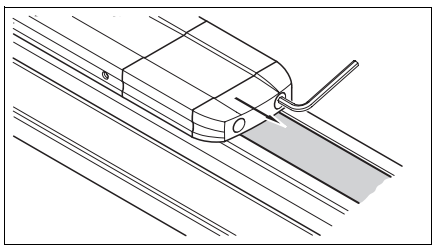
■ You need a set of Allen keys, metal shears, a new cover strap and two new turning blocks.



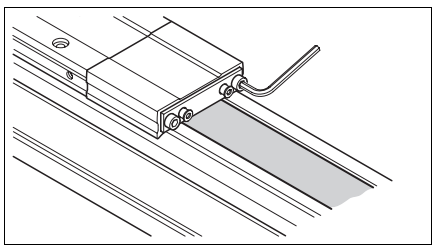
▶ Loosen the two screws; they fasten the pressure plate and thus the cover strap.



▶ Loosen the two screws and remove the strap clamp. Make sure that none of the screws or the pressure plate is dropped.



▶ Remove the buffer on the turning block. To do this loosen the two screws.



▶ Remove the turning block. To do this loosen the two screws.

You can now remove the turning block.

▶ Pull the cover strap completely out.

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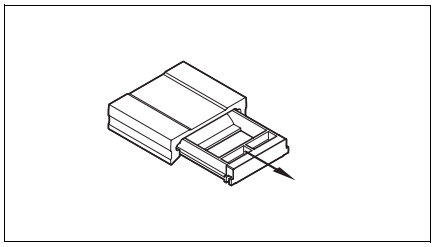
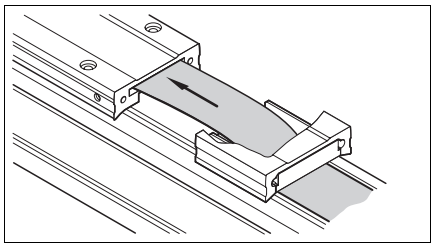
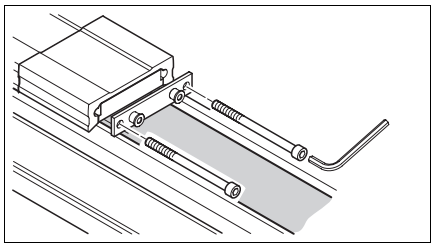


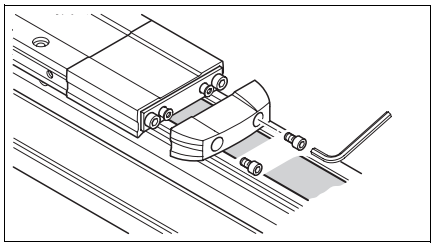
- Remove the old plastic unit from the retainer. Insert the new plastic unit.



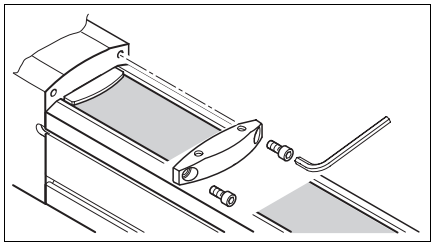
- Cut the new cover strap to the same length as the old cover strap with the shears. If the old cover strap is not available, the cutting is described below.
- Insert the new cover strap through the guide channel inside the carriage and through the turning blocks.



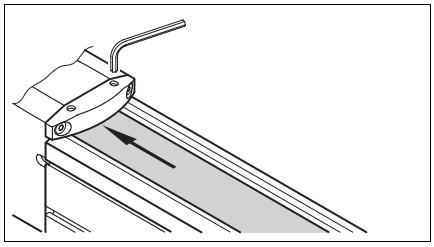
- Position the retainer plate for the plastic unit with the two press-in sockets for fastening the buffer on the carriage.
- Screw the turning block in place.



- Mount the buffer with the screws and washers.



- Position the cover strap along the axial section and align it symmetrically and evenly. Make sure that it is positioned flat in the magnetic strips.
- If it has not been cut as described above, cut the cover strap to the length that will allow it to be fixed at both ends with the pressure plates.
- Position the pressure plate.
- Screw the strap clamp in place.

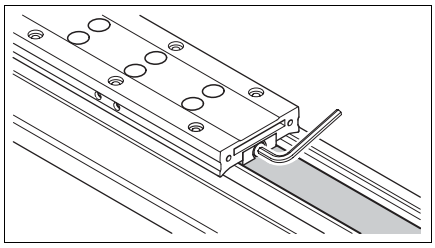


- Tighten the threaded pins lightly to fasten the cover strap to the pressure plate.

9.3.4 Replacement of toothed belt

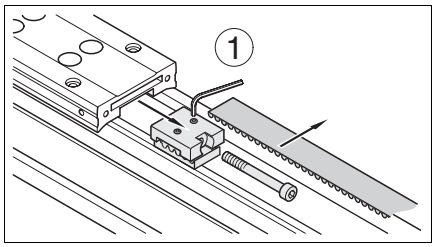
The toothed belts are low-maintenance. However, if it is necessary to replace a belt, proceed as follows on both sides of the carriage or linear axis.

- You need a set of Allen keys and a replacement belt (cut to size if necessary). You will need a belt tension gauge to measure the exact pretension of the belt.
- ▶ Remove the cover strap (if installed) and the turning blocks as described on page 9-6.



Removing toothed belt

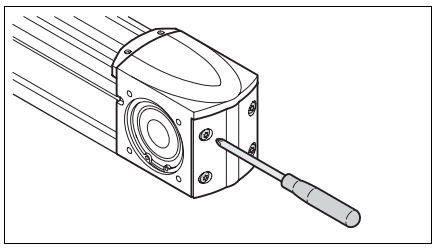
- ▶ Loosen the screw for the tension lock.



- ▶ Remove the tension lock with the attached toothed belt as a unit.
- ▶ Loosen the two threaded pins (1).
- ▶ Slide the toothed belt out to the side. Note that the pressure plate can also be slid out.
- ▶ Pull the toothed belt out of the axial section.

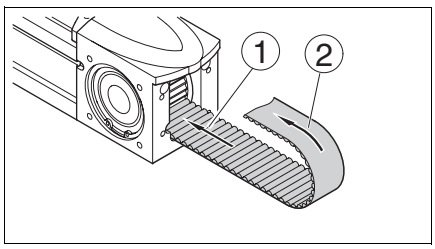
Cutting new toothed belt

- ▶ Cut the new toothed belt to the same length (tooth count) as the old belt. This is necessary to ensure that the same belt tension can be set after installation.
- ▶ Measure the length of the old toothed belt. The length is required if you calculate the belt pretension of the new toothed belt with the so-called "one per thousand rule".



Installing toothed belt

- ▶ Remove the covers on the two end blocks. To do this loosen the four screws.



- ▶ Guide one end (1) of the new toothed belt through an opening in the end block. Make sure that the teeth are upwards.
- ▶ Insert the other end (2) through above the gear wheel.

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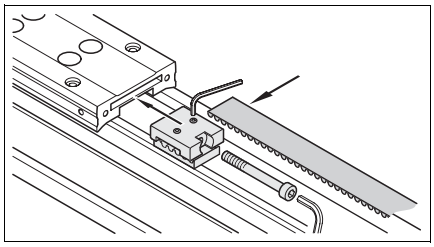

Fastening toothed belt to tension lock

- ▶ Insert the end of the belt with the pressure plate into the tension lock over all five teeth.

  Make sure that the pressure plate is flush and the toothed belt is symmetrically place in the tension lock.
- ▶ Tighten the threaded pins lightly.
- ▶ Insert the tension lock into the carriage.

Pretensioning toothed belt

Size	Toothed belt pitch width	Resulting belt pretension	
PAS41	3-15	[N]	145
PAS42	5-25	[N]	572
PAS43	5-30	[N]	672
PAS44	8-50	[N]	1917

Table 9.1 Required belt tension

The belt must be pretensioned sufficiently so the belt still has a residual pretension at maximum driving torque (i.e. does not slip over the gear wheel). This depends on the maximum driving torque.

On the other hand the belt tension must not be too great or the belt will be loaded unnecessarily.

The belt is tensioned to the value as in Table 9.1 by rotating the two tension locks evenly with the screws in the carriages. If a belt tension gauge is available, use it to measure the belt tension.

If a belt tension gauge is not available, the pretension can be set with the "one per thousand rule".

- ▶ Rotate the screws of the two tension locks evenly until the belt is just straight, i.e. does not hang.
- ▶ Calculate one thousandth (1 per thousand) of the toothed belt length in mm.
- ▶ Rotate the two tension locks evenly into the carriages by half of the calculated mm value. 1 revolution of the screw (M5) is 0.75 mm.

Final actions

- ▶ Mount the turning blocks and if applicable the cover strap as described on page 9-6.

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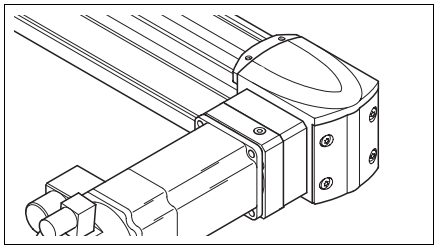
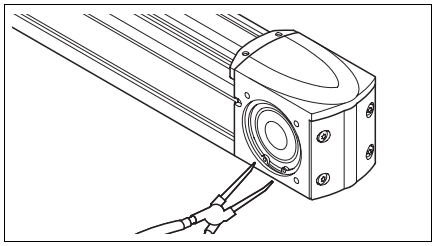
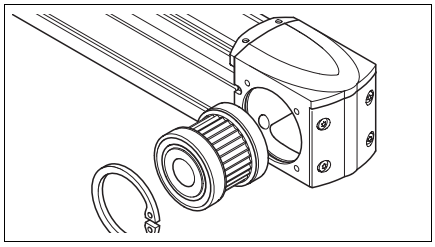
9.3.5 Replacement of gear wheel



- You will require a Seeger ring and the tools for disassembly and mounting the drive (motor), cover strap and toothed belt.
- ▶ Remove the motor, gearing or drive shaft if you have a drive side gear wheel. See chapter 9.3.2 "Replacement of motor, gearing or drive shaft"
- ▶ Remove the cover strap and the strap turning blocks (if installed) as described on page 9-6.
- ▶ If applicable, remove the toothed belt as described on page 9-8.



- ▶ Remove the circlip on one side of the end block with the Seeger ring.



- ▶ Remove the gear wheel with bearing as a unit.
- ▶ Install the new gear wheel with bearing.
- ▶ Mount the circlip.
- ▶ Mount the toothed belt as described on page 9-8.
- ▶ Mount the cover strap as described on page 9-6.
- ▶ If applicable, mount the shaft journal as described on page 5-9.
- ▶ If applicable, mount the motor as described on page 5-6.

9.4 Shipping, storage, disposal

Note the ambient conditions on page 3-1!

Shipping The product must be protected against shocks during transport. Use the original packaging for this purpose.

Storage Store the product only under the specified, approved environmental conditions for room temperature and humidity.
Protect the product against dust and dirt.

Disposal The product consists of various materials that can be recycled and must be disposed of separately. Dispose of the product in accordance with local regulations

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10 Glossary

10.1 Terms and Abbreviations

Axial section	The linear axis is based on a high-rigidity precision aluminium section.
Breakaway torque	The breakaway torque describes the driving torque required to overcome the static friction and that initiates the transition to sliding friction.
Centring collar	centric protrusion on the motor flange to ensure precise assembly.
Drive constant	The drive constant shows the path of the carriage that is covered by one revolution of the axis drive.
ESD	(**E**lectro **S**tatic **D**ischarge) is the electrostatic discharge and describes the processes and effects during compensation of electrical charges.
Load torques	The permissible load torques must be calculated corresponding to the service life. If the load torques exceed the specified values the service life of the axis will be reduced.
Modulus of elasticity	The modulus of elasticity is a material quantity that describes the connection between tension and extension during deformation. The higher the values the stiffer the material.
Mounting position	The linear axes can be installed in any desired position. However, note that all forces and torques must be below the maximum values of the axes.
Path	The path is the stroke between the switching points of the positive and negative limit switches. When specifying lengths a safety path between the limit switches and the mechanical stop must be provided.
Positioning accuracy	Positioning accuracy is the tolerance between a specified position and actual end position. The positioning accuracy is influenced by changes in temperature, load and speed and the accuracy of the switching point of the reference sensors.
Recirculating ball bearing guide	The axial section receives the forces and torques applied to the carriage via the recirculating ball bearing guide. High forces and torques can be received with recirculating ball bearing guides.
Repeat accuracy	The repeat accuracy is the capacity to reach a previously reached position again under the same conditions. The repeat accuracy is influenced by changes in temperature, load and speed and the accuracy of the switching point of the reference sensors.
Roller guide	The axial section receives the forces and torques applied to the carriage via the roller guide. See recirculating ball bearing guide.
Self-locking	The axes are not self-locking. This means that motors with a holding brake, a separate holding brake or suitable weight compensation for the linear axis is required, particularly when axes are vertically mounted.
Sensors	Inductive proximity switches are used as sensors for limit switches or reference switches. These switches are small safety limit switches as specified by EN60204-1.
Sequence accuracy	The aluminium sections are extruded sections that have deviations in straightness and torsion because of the manufacturing process. The tolerance of this variation is specified in EN 12020-2. The linear unit must

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be tensioned on an appropriately accurately machined base to achieve the desired guideway accuracy.

Service life The service life is the path travelled by a linear axis before the first signs of material fatigue can be seen on the guideways, the drive components and the bearings. Service life specifications (kilometres covered) are based on the nominal values in the data sheet. If the nominal values are exceeded the service life will be correspondingly reduced.

Stiffness The stiffness shows information on the capacity of part that is to be positioned to move and stop at the correct position, even under load variations.

Stroke The stroke is the path covered by the carriage between the switching points of the limit switches.

Stroke reserve The stroke reserve is the distance between the limit switches and the mechanical end stop.

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